SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; CHARLES D. WALCOTT, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology.

FRIDAY, DECEMBER 12, 1902.

CONTENTS:

Address of the President of the Botanical Section of the British Association for the Advancement of Science: PROFESSOR J. REYNOLDS GREEN 921
The American Ornithologists' Union: JOHN H. SAGE 938
A Graduate School of Engineering Research 940
Scientific Books:—
Dr. Meyer on some European Museums: F. A. L. 941
Scientific Journals and Articles 943
Societies and Academies:—
The American Association for the Advancement of Science. The Biological Society of Washington: F. A. LUCAS. *The Botanical Society of Washington:* DR. HERBERT J. WEBBER 944
Discussion and Correspondence:—
The Grand Gulf Formation: PROFESSOR WM. H. DALL. *The Squids from Onondaga Lake, N. Y.:* DR. JOHN M. CLARKE 946
Shorter Articles:—
Preliminary Results on the Changes of Atmospheric Nucleation: PROFESSOR CARL BARUS. *The Laramie Cretaceous of Wyoming:* PROFESSOR S. W. WILLISTON 948
Botanical Notes:—
Air Humidity; Polyporus Officinalis in America; Botany in the Washington Meeting; Two Books on Forestry; Three Forestry Journals: PROFESSOR CHARLES E. BESSEY 953
The Virchow Memorial 955
Lecture Courses of the National Geographic Society 956
A General Meeting of the American Philosophical Society 957
Scientific Notes and News 958
University and Educational News 960

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ADDRESS OF THE PRESIDENT OF THE BOTANICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

THE visits of the British Association to a particular city recur with a certain irregular frequency and bring with them a temptation to the president of a section to dwell in his opening address on the progress made in the science associated with that section during the interval between such consecutive visits. This course possesses a certain fascination of its own, for it enables us to realize how far the patient investigations of years have ultimately led to definite advances in knowledge and to appreciate the difficulties that have involved disappointments, and that still have to be surmounted. We like to look back upon the struggles, to record the triumphs, to deplore the failures, and to brace ourselves for new efforts. The opportunity afforded hereby for criticism of methods, for reconsideration of what have been held to be fundamental principles, for the laying down of new lines of work based upon longer experience, shows us how desirable such a periodical retrospect may be.

Standing as we do almost at the threshold of a new century, it seems particularly advisable that we shall occupy our thoughts with some such considerations to-

* Belfast meeting, 1902.

day. I do not wish, however, so much to dwell upon the past and to lead my hearers to rest in any way satisfied with the achievements of the last century, phenomenal as they have been, as to direct attention to the future and to place before you some of those problems which at the opening of the twentieth century we find awaiting investigation, if not solution.

I can only attempt to deal with a small portion of the botanical field. These are the days of specialization, and when anyone is said to be a botanist, the question which arises at once is, Which particular section of botany is he associated with? The same principle of subdivision which cut up the old subject of natural history into zoology, botany, and geology has now gone further as knowledge has increased, and three or perhaps four departments of botany must be recognized, each demanding as much study as the whole subject seemed to only fifty years ago. I shall therefore confine my remarks to-day to the field of vegetable physiology.

I should like at the outset to recommend this section of botanical work to those of the younger school of botanists who are contemplating original research. To my mind the possibilities of the living organism as such present a fascination which is not afforded by the dry bones of morphology or histology; valuable as researches into the latter are, they seem to me to derive their importance very largely from the past, from the possibility of indicating or ascertaining the line of descent of living forms and the relation of the latter to their remote ancestors. The interest thus excited seems to me to be rather of an academic character when compared with the actual problems of present-day life, its struggles, triumphs, and defeats in the conflict for existence waged to-day by every living organism. The importance of the study of physiology as bearing upon the problems of the morphologists has, I need hardly say, been fully recognized by the workers in that field. I may quote here a sentence or two from the address of one of my distinguished predecessors, who said at Liverpool, "There is a close relation between these two branches of biology, at any rate to those who maintain the Darwinian position, for from that point of view we see that all the characters which the morphologist has to compare are, or have been, adaptive. Hence it is impossible for the morphologist to ignore the functions of those organs of which he is studying the homologies. To those who accept the origin of species by variation and natural selection there are no such things as morphological characters pure and simple. There are not two distinct categories of characters—a morphological and a physiological category—for all characters alike are physiological."

But apart from the considerations of the claims of vegetable physiology based upon its own intrinsic scientific value and the interest which its problems possess for the worker himself, and upon the place accorded to it as its relationship to morphology, it must, I think, be recognized as being of fundamental economic importance, especially in these times of agricultural depression. For many years now it has been recognized that agriculture is based upon science; that it involves indeed properly the application of scientific principles to the cultivation of the soil. But when we look back upon what has passed for agricultural science since the alliance between the two has been admitted, we cannot but recognize how lamentably deficient in breadth it has been. The chemical composition of the soil and subsoil has been investigated with some thoroughness in many districts of the country. The effect of its various constituents on the weight and quality of the crops cultivated in it has been exhaustively inquired

into, and a considerable amount of information as to what minerals are advantageously applied to the soil in which particular plants are to be sown has been acquired. A kind of empirical knowledge is thus in our possession, in some respects a very detailed one, quantitative as well as qualitative records being available to the inquirer. But elaborate as have been the researches in these directions, and costly and troublesome as the investigations have been, they have been hardly, if at all, more than empirical. Till quite recently the physiological idiosyncrasies of the plants round which all these inquiries centered were almost entirely ignored. No serious attempt was made to ascertain the way in which a plant benefited by or suffered from the presence of a particular constituent of the soil. What influence, for instance, has potassium or any of its compounds upon the general metabolism of the plant? Does it affect all its normal nutritive processes, or does it specially associate itself with some particular one? If so which one, and how does the plant respond to its presence or absence by modifying its behavior? So with phosphorus again; hardly any investigation can be made into the nutritive processes of a plant without this element becoming more or less prominent. In some cases the empirical results already referred to show an enormous influence on the crop exerted by soluble phosphates in the soil or the manure applied to it. But what can yet be said as to the rôle played by phosphorus or by phosphates in the metabolic processes in the plant? Further, how do different plants show different peculiarities in their reaction to these various constituents of the soil? For the advance of agriculture the study of the plant itself must now be added to the study of the soil. The fact that it is a living organism possessing a certain variable and delicate constitution, responding in particular ways to differences of environment, capable of adapting itself to a certain extent to its conditions of life, dealing in particular ways with different nutritive substances, must not only be recognized, but must be the basis for the researches of the future, which will thus supplement and enlarge the conclusions derived from those of the past, in some respects correcting them, in others establishing them on a firmer basis.

In pressing upon the younger school of botanists the importance of this line of research, I do not wish to minimize the difficulties that accompany it. Difficulties of method assume considerable magnitude, for we have here no question of section cutting and microscopic examination. Vegetable physiology is allied very closely to other sciences, and research into its mysteries involves more than a preliminary acquaintance with them. Especially must one point out the importance, indeed the necessity, of acquaintance with a certain range of organic chemistry and with chemical methods of work. In certain directions, too, physics are as much involved as chemistry in others. The bearing of these sciences in particular directions will be referred to later.

I fear another obstacle stands at the threshold of research which looks sufficiently formidable. The so-called fundamental facts of vegetable physiology have been laid down with sufficient dogmatism in text-books by many writers whose names carry with them such weight that it appears almost heresy to question their statements. We have been content to accept many things on the authority of the great workers of the past, with the result that the advance of knowledge has been hindered by such acceptance of what were deemed facts, but were really inaccuracies. We may refer, for instance, to the statement made by Boussingault, and accepted by most botanists ever since his time, that

the absorption of carbon dioxide from the air takes place by means of solution in the cuticle of the epidermal cells of plants and thence passes by diffusion to the seats of photosynthesis. Only comparatively recently has this been shown to be erroneous. If, however, it is once recognized that authority is fallible this apparent obstacle becomes the opposite. The more evident questions have not yet been solved, leaving only the more difficult ones for the present-day worker.

Recognizing the importance of work in this field, and realizing that with the advent of a new century new departures must be taken, I have thought I might venture to direct the thoughts of my hearers, many of whom I may call my colleagues, to the present position of certain problems which have long been the subjects of speculation and which offer the prospect, if not of complete solution, at any rate of considerable advance if investigated by modern methods.

I turn first to a few questions connected with the nutritive problems of plants in general.

There are several theories abroad as to the progress of events during photosynthesis, none of which can be regarded as entirely satisfactory. For many reasons it seems desirable that this question shall be thoroughly investigated in the light of the present condition of both chemical and physical science. I may perhaps venture to recall to you the principal hypotheses of carbohydrate formation which have been advanced, so that its present position may be properly appreciated.

The view that has met with the widest acceptance is that of Baeyer. On his hypothesis the carbon dioxide absorbed is decomposed under normal conditions to yield carbon monoxide and oxygen; a corresponding and coincident decomposition of water leads to the production of free hydrogen and oxygen. The oxygen from both sources is exhaled, while the carbon monoxide and hydrogen combine to form formaldehyde. The formaldehyde gives rise by a process of polymerization to some form of sugar.

A modification of this hypothesis has been advanced, which suggests that the preliminary decomposition of the carbon dioxide and the water may not take place, but that by a rather less violent reaction between them the formaldehyde may be formed and the oxygen liberated.

Erlenmeyer has suggested a somewhat different course of reaction, yielding substantially the same results. He thinks it possible that the first interaction of carbon dioxide and water leads to the formation of formic acid and hydrogen peroxide, and that these subsequently interact with each other, yielding formaldehyde and water and giving off oxygen.

Many years after the views of Baeyer appeared, a hypothesis of a different nature was proposed by Crato. He suggests that the carbon dioxide after absorption becomes ortho-carbonic acid, and that this remains in solution in the cell sap. This acid has the structure of a closed benzene ring in which six molecules are linked together. This becomes decomposed, liberating six molecules of water and six molecules of oxygen, and forming a hexavalent phenol which subsequently undergoes a molecular rearrangement and becomes glucose.

Yet another suggestion was made by Bach in 1893. He points out that when sulphurous acid is exposed to light it becomes transformed to sulphuric acid, sulphur and water being split off, and he argues that a process analogous with this may take place in a leaf. The carbon dioxide uniting with water would form carbonic acid, and this might then split up in the same way as the sulphurous acid. The carbon and the water thus split off are on this hypothesis not set free sepa-

rately, but in combination as formaldehyde. The higher carbon acid, to which Bach ascribes the formula H_2CO_4, splits up into carbon dioxide and hydrogen peroxide, and the latter is decomposed into water and free oxygen.

Lieben has still more recently put forward the view that formic acid and not formaldehyde is formed by the first decompositions. He has found that leaves of grasses and various trees yield formic acid among other products when mixed with their own weight of water containing a trace of sulphuric acid, and distilled with steam. Moreover, when carbon dioxide is acted upon by nascent hydrogen the only product is formic acid.

These speculations afford many points which might be well made the starting places of research. The views of Baeyer have met with most acceptance, though but little success has attended the few efforts that have been made to establish them by experiment.

They involve several definite stages of action, of which the most important seem the production of carbon monoxide and hydrogen, the formation of formaldehyde, and the construction of a sugar. The last two questions arise also in connection with the hypothesis of Bach.

If we examine the work that has been published bearing on the probability of the formation of carbon monoxide in the plant, we find little that is satisfactory. The statements that have been made are opposed to the idea that carbon monoxide is of value in nutrition; it is said that when supplied to a plant instead of carbon dioxide it does not lead to the formation of carbohydrates. It is further advanced that this gas is of a very deleterious nature, and if formed would result in the speedy death of the protoplasm of the cell in which it originates. This idea is, of course, specious; but it does not appear to be well founded. The deadly character of carbon monoxide when inhaled by a human being depends upon a peculiar interference which it causes with the oxygen-carrying power of the red blood corpuscles. The pigment hæmoglobin to which these little bodies owe their usefulness forms a loose chemical combination with oxygen, the compound being formed in the blood vessels of the lungs and being decomposed with the liberation of the oxygen in those of the tissues of the body. It is evident, therefore, that the value of the corpuscles as oxygen-carriers depends upon their hæmoglobin. When this pigment is exposed to carbon monoxide it combines with it in the same way as it does with oxygen, forming, however, a more stable compound. The affinity for this gas which the pigment manifests is very considerable. Hence the poisonous nature of carbon monoxide. It is easily seen that the latter is a poison because it throws out of gear and temporarily paralyzes a most essential part of the mechanism of respiration, effectually preventing oxygen from reaching the tissues of the body. There is no evidence here that it exerts even a deleterious influence upon the living substance itself. The only poisonous effect it would be able to exert on the plant would necessarily be of the latter character, for there is no oxygen-carrying mechanism that could be interfered with. We cannot lay any stress, therefore, on the objection to Baeyer's view, based upon the action of carbon monoxide upon the human organism.

Another possibility may, however, be mentioned. As we shall see later, there are certain resemblances between hæmoglobin and chlorophyll, the vegetable pigment concerned in photosynthesis. May not carbon monoxide enter into some relationship with the latter, and thereby indirectly hinder its activity? Of that, however, there is no reliable evidence, the facts known to us rather pointing in the opposite direction.

The idea of the poisonous nature of this gas may easily be subjected to experimental examination. It would appear easy to expose a plant to an artificial atmosphere made up to different partial pressures of carbon monoxide, to expose it in such atmosphere to various conditions of warmth and illumination and to note the effect produced. It would seem possible to examine a great variety of plants in that way, to try both aerial and aquatic forms, and indeed to test the matter exhaustively. It must be borne in mind, however, that the solubility of carbon monoxide in water is extremely small, and that there may be a great difficulty in getting it brought within the scope of the influence of the living substance on that account. It must necessarily be in solution in the cell sap before it can affect the activity of the chloroplast. Even the relations of solubility are not, however, outside the range of experiment, and it may be that the slightly acid cell sap has not the same peculiarities as water as a solvent for the gas.

It is important again to take into account in such work the factor of sunlight, on which the power of photosynthesis depends. Should carbon monoxide prove capable of serving as a basis for the formation of carbohydrates, the question would arise, Is the activity of the chlorophyll in sunlight confined to the preliminary formation of carbon monoxide from the dioxide, or is the energy derived from the light brought to bear upon the subsequent constructive processes? We have little or no accurate information as to the way in which the energy is utilized after absorption by the chlorophyll.

This opens up a very important but very difficult line of work, which brings home to us the intimate dependence of vegetable physiology upon physics. The absorption of energy from without, in the form of the radiant energy of the solar rays, is certainly a fact, and to a certain extent we can picture to ourselves the way in which it is secured. The spectrum of chlorophyll shows us a number of absorption bands whose position corresponds with the position in the spectrum of the places where oxygen is liberated in photosynthesis. But the transformation and applications of energy in the body of the vegetable organism need much closer examination. The intimate relationship between the different manifestations or forms of energy and the ways in which they can be transformed into one another have been very minutely scrutinized in recent times. What then should hinder us from learning something much more definite than we at present know about these transformations in the rôle of vegetable life? The electrical phenomena connected with the movements of the leaves of the Venus's fly-trap (*Dionæa muscipula*) have been examined with considerable completeness by Burdon Sanderson, and we have learned that the vegetable and animal organisms show considerable similarities in this respect. Recently again Bose has made important contributions to the subject of the electrical responses to stimulation that can be observed under particular conditions. A promising beginning has thus been made, but only a beginning. The electrical condition of the normal plant under different conditions of rest and activity has still to be investigated. If we return to the subject of photosynthesis and the work done by the chloroplast, may we not hope to discover something about the transformation and utilization of the radiant energy associated somehow with this structure? Considering the relations between the manifestations of energy which we appreciate respectively as light and electricity, it does not seem wildly improbable to imagine that the energy absorbed as the former may lead to a possible electrolysis of carbonic acid under the influence of the

chloroplast, with the formation of carbon monoxide and oxygen. Pfeffer has suggested that perhaps the decomposition of the gas is not due to the light rays at all, and that they may exercise only a stimulating influence upon the chloroplast, the energy concerned being derived from heat rays directly absorbed, or heat vibrations derived from the more rapidly vibrating light rays. In this case is the decomposition brought about directly by the heat vibrations, or have we a transmutation into some other form of energy? The whole subject seems at all events a promising subject for inquiry.

Another problem connected with the action of chlorophyll is associated with the absorption of radiant energy by the different regions of the spectrum. Bands of considerable intensity are noticeable in the blue and violet, though the deepest absorption takes place in the red. Yet Engelmann's classic bacterium method shows us that very little evolution of oxygen takes place in the position of these bands in the blue and violet. The fact that absorption of radiant energy and photosynthetic activity show no quantitative relationship is of course not new, but the reason remains still to be discovered. Van Tieghem has suggested an explanation which recalls to us the hypothesis advanced by Pfeffer, just alluded to. This explanation is that there are two factors concerned in the action of chlorophyll, the elective absorption of light, shown by the occurrence of the absorption bands in the spectrum, and the calorific energy of the absorbed radiations. The failure of the rays of the blue and violet to effect photosynthesis, in spite of their absorption, would on this view be attributable to their possessing but little calorific energy. The latter is associated much more strongly with the deep band in the red, which is the seat of the maximum evolution of oxygen when the spectrum is thrown upon a collection of active chloroplasts. The heating rays alone are ineffectual, as shown by the fact that there is no liberation of oxygen in the region of the infrared, due no doubt to the fact that chlorophyll does not absorb these rays.

Timiriazeff, in his classical researches on the liberation of oxygen by the leaves of the bamboo when exposed in tubes of small caliber to a large spectrum, found that the amount of carbon dioxide decomposed by leaves is proportional to the distribution of effective calorific energy in the spectrum.

Van Tieghem's hypothesis that this is a matter of calorific energy may prove to be erroneous, and yet his views may rest on some sound basis. It may be a matter in which electrical rather than calorific energy may be concerned.

Returning now to the chemical steps demanded by Baeyers's hypothesis, there are certain considerations which may be urged in favor of the view that carbon monoxide really occurs in photosynthesis. It has been ascertained by Norman Collie that when a mixture of gases containing a large proportion of carbon dioxide is exposed at low pressures in a vacuum tube to the action of an electric discharge from an induction coil there is a very large formation of the monoxide, together with oxygen, in some cases as much as seventy per cent. of the gas undergoing decomposition.

Appealing to the experience of various observers, there seems on the whole to be a balance of evidence in favor of the power of plants to live and prosper in an atmosphere containing a very considereable percentage of carbon monoxide.

The question of the possibility of the latter replacing the dioxide, as the theory appears to require, is complicated very seriously by the differences of solubility between them. Carbon dioxide dissolves very readily in water and in cell sap; carbon monoxide is almost insoluble in either.

As the amount of a gas taken up by a solvent depends not only on its solubility, but upon its partial pressure, it is very evident that we cannot compare the two gases by admitting the same quantity of both to plants under simultaneous comparison. It is only necessary to supply the dioxide in the proportion of four parts in 10,000; but the almost insoluble nature of the monoxide makes it inevitable that from two to five per cent. shall be experimented with. The same question of solubility makes it almost out of the question to experiment with an aquatic plant.

It would be of considerable interest from this point of view also to inquire whether if carbon monoxide is liberated at the outset of the photosynthetic processes its combination with other groupings can take place apart from the action of chlorophyll. If so the fungi should be capable of carbohydrate construction if supplied under proper conditions with the monoxide and with hydrogen. The proper conditions, however, might be extremely difficult to establish.

The next stage in the constructive process affords still ample room for investigation. The presence of formaldehyde is not the hypothesis of Baeyer alone, but is demanded according to Bach's views, though the stages of its hypothetical construction are not the same. We have therefore to ask whether formaldehyde can be detected in plants, and if so whether the conditions under which it may exist admit of its being considered an up-grade product in photosynthesis. Objections to the theory of its formation may be advanced, based upon its undoubtedly poisonous nature. Of all the antiseptics now available to the bacteriologists it is perhaps the most potent, even traces being fatal to the form of vegetable protoplasm which is found in bacteria. We may argue that it must be equally deleterious in the cell containing chlorophyll and to the chloroplast itself, as we have no reason to suppose that any difference in vitality exists between the protoplasm of different plants. At first sight this appears an almost insuperable difficulty in the way of the theory. Formaldehyde has, however, the properties of aldehydes in general, one of which is the power of condensation or polymerization. It passes with extreme readiness into a much more inert form, para-formaldehyde, a body in which three molecules of the formaldehyde are grouped together. It is therefore possible that it may be prevented from exercising its deleterious properties by a transformation at once into this comparatively harmless modification. This will slowly decompose under proper conditions, giving off the free aldehyde.

Pollacci has stated that it is possible to extract formaldehyde from leaves. In his experiments he took such as had been exposed to light for a very considerable period and then macerated them in water. After a sufficient extraction he distilled the leaves, together with the water in which they had been steeped. The first portions of the distillate yielded reactions indicative of the presence of formaldehyde. His experiments do not enable us to say that free formaldehyde was there, for the more stable *para*-form would be likely to decompose during the distillation, so that the reactions would be explained without demanding the presence of the free aldehyde in the leaves.

But little success has attended hitherto the attempt to show that formaldehyde, in the presence of chlorophyll, or preferably, we may say, of chloroplasts, can give rise to carbohydrates. We have nothing more satisfactory than Bokorny's experiments, in which, after failing to set up photosynthesis in a filament of *Spirogyra* fed with formaldehyde, he succeeded when he supplied the alga with its compound with

sodium-hydrogen-sulphite. Experiments on a more comprehensive scale, conducted on a variety of plants of different habits, are needed before we can regard the process as satisfactorily established.

We have further to pursue the problem by an inquiry as to the nature of the sugar first formed. Certain considerations lead to the view that it is probable that a sugar of the aldose type must be accompanied in the plant by a ketose. The hypothesis as stated by Baeyer, and so far accepted till quite recently, took no account of the latter. The aldose *grape sugar* was the one always suggested, and from this all others met with have been held to be constructed. The first appearance of a ketose, *levulose*, or *fruit sugar*, has been associated with the hydrolytic decomposition of *cane sugar*, itself constructed presumably from the grape sugar. I fear sufficient attention has not been paid to probability or to the normal course of chemical action in framing our hypotheses, for it is rather difficult to see how some of the transformations somewhat dogmatically affirmed can possibly take place. I may refer in passing to the statement that in the digestion of fat or oil during germination part of it is converted into starch or sugar.

But to return to the construction of sugar. The condensation of formaldehyde, which can be brought about by the action of basic lead carbonate, leads to the formation of several sugars, each yielding its characteristic osazone. How far the condensation in the plant follows this is still uncertain. It is quite possible that stages intervene between formaldehyde and sugar of any kind. It has been suggested that formaldehyde in the presence of water may under the conditions obtaining in the leaf give rise to glycolaldehyde, a body which forms sugar very readily indeed. The formation of sugar directly from formaldehyde is a much longer process and is attended with greater difficulty.

I may call your attention here to the views of Brown and Morris traversing the theory of the primary carbohydrate being grape sugar. In their classical paper on the chemistry and physiology of foliage leaves they have adduced strong evidence, based upon analyses of the sugar-content of leaves of *Tropæolum majus*, that in this plant at any rate the first sugar to be formed is cane sugar. Whether or no this is the case in plants generally cannot at present be said, though it appears from many considerations probable.

The part played by chlorophyll in photosynthesis has already been touched upon. Remarkably little is known about chlorophyll itself. It has so far been found impossible to extract it from the chloroplast without causing its decomposition, and hence our ideas of its constitution, such as they are, are based upon the examination of something differing in some not well-ascertained particulars from the pigment itself. A remarkable relationship is known to exist between the latter and iron, for unless this metal is supplied to a plant its chloroplasts do not become green. But the condition of the iron in the plant is uncertain; it seems probable that it does not enter into the molecule of the pigment at all. A remarkable series of resemblances between derivatives of chlorophyll and derivatives of hæmatin, the coloring matter of hæmoglobin, has been brought to light by the researches of Schunck and Marchlewski, which is very suggestive. The same leaning towards iron is found in the two pigments, but in the case of hæmatin our knowledge is further advanced than in that of chlorophyll. The iron is known to be part of its molecule. It can by appropriate treatment be removed, and a body known as *hæmatoporphyrin* is then formed, which presents a most striking similarity

to a derivative of chlorophyll which has been named *phylloporphyrin.* The two pigments are almost identical in their percentage composition, the hæmatoporphyrin containing a little more oxygen than the other. Both seem to be derivatives of pyrrol. The most striking similarity between them is their absorption spectra, their ethereal solutions both showing nine bands of identical width and depth, those of hæmatoporphyrin being a little more towards the red end of the spectrum. Their solutions in alcohol and ether show the same color and the same fluorescence. Though they differ in certain other respects, notably the facility with which they form crystals, it is impossible to deny that a close relationship seems probable. If this is established we may by analogy perhaps learn something about the part played by iron in the action of the chloroplast, which so far has proved as obscure as the relation of the metal to the pigment. It is very suggestive to recall the resemblances between the two pigments, the one playing so prominent a part in animal, the other in vegetable life. Both are associated with a stroma of proteid, or possibly protoplasmic, nature, in which a solution of the pigment is retained, apparently after the fashion of a sponge. Both are concerned in metabolic processes in which gaseous interchanges play a prominent part. Both are in some way dependent on the presence of iron for their individuality, even if iron is not actually present in the molecule of both. The iron being removed, the derivatives which are found are almost identical. Further researches may throw a light on this curious relationship, perhaps showing that chlorophyll may enter into a combination with carbon dioxide as hæmatin does with oxygen. Such a combination might well be the precursor of the decomposition of the carbon dioxide which has been already spoken of.

We meet with another pigment in many plants, the physiological significance of which has in recent years begun to attract some attention. This is the red coloring matter, *anthocyan,* apparently related to the tannins, which is developed especially in the young leaves of shade-loving plants when they become exposed to illumination exceeding the intensity which they normally encounter. The formation of this pigment is greatest in tropical plants, where it is found usually in the epidermis of the young leaves, though in some cases it extends to the mesophyll as well. The pigment seems in some way to be supplementary to chlorophyll, for its absorption spectrum shows that it allows all the rays useful in photosynthesis to pass through it. It is unlikely that it takes any share in photosynthesis. Several theories have been advanced to explain its presence; it may be simply to protect the delicate cells from the destructive action of too intense light, or to avert the evil of overheating from the solar rays. It has been suggested that certain rays hinder the translocation of starch, and that the pigment shields the cells from the incidence of such rays. Again the view has been advanced that the red color is important in accelerating the development of diastase from its antecedent zymogen, which has been found to take place under the influence of the rays of a certain region of the spectrum. While all these views have been advanced, however, there is little positive information bearing upon either the formation or the function of the pigment.

Very little progress has been made with the problem of the construction of proteid matter in the plant, which still confronts us. The question of its relation to the mechanism of photosynthesis has received some attention without leading to any satisfactory conclusion. Winogradski's success in cultivating the nitrate bacteria upon

purely inorganic matter reveals an unexpected constructive power in some forms of vegetable protoplasm. The question of the energy made use of in proteid construction is in an equally unsatisfactory condition. Laurent, Marchal and Carpiaux have stated that the rays of the violet and ultra-violet region of the spectrum are absorbed and devoted principally to the construction of nitrogen compounds from the nitrates, or the compounds of ammonia, which are absorbed by the plant, while the intervention of the chlorophyll apparatus is unnecessary for this purpose. The experiments which they give in considerable detail upon this absorption carry much weight and appear conclusive. Unfortunately other observers have failed to confirm them, so that at present the matter must be left open.

Among the problems connected with the nutrition of the plant, the part played by alcohol has recently come into prominence. Alcohol was originally associated only with the lower fungi, and especially with the yeast plant. Biological problems of grave importance arose in connection with the Saccharomyces, apart from what seemed at first the larger question, viz., the nature of fermentation. A prolonged study of the latter phenomenon led Pasteur to the view that alcoholic fermentation is only the expression of the partial asphyxiation of the yeast, and its efforts to obtain oxygen by the decomposition of the sugar. It is hardly necessary here to remind you of the controversies that centered about the question of fermentation and the theories held and abandoned as to its cause. The biological phenomena have, however, a claim now upon our attention in the light of some very remarkable researches that are calling for our attention and criticism to-day. Pasteur's explanation of the behavior of the yeast was, as we have seen, such as to connect it with the respiration of the plant. When oxygen was withheld from active yeast sixty to eighty parts of sugar disappeared for one part of yeast formed. When oxygen was present not more than ten parts of sugar were decomposed for the same amount of yeast production. Undoubtedly the stimulus of asphyxiation materially stimulated the yeast metabolism.

But certain observations did not agree with Pasteur's explanation. An energetic fermentation takes place in the presence of oxygen, the plant multiplies extremely quickly, and its metabolism appears very active. Schützenberger argued against Pasteur's explanation with some force, emphasizing these points of disagreement between his hypothesis and the facts, and claimed that the matter rather concerned nutrition than respiration. He based his view on experiments carried out to ascertain how respiration was affected under changed conditions.

The results he obtained were briefly the following:

1. In a watery liquid without sugar, but containing oxygen in solution, the quantity of oxygen absorbed in unit time by a gram of yeast is constant, whatever proportion of oxygen is present.

2. In a saccharine liquid containing albuminous matter as well as sugar, and with oxygen in solution, the same result is obtained, except that the quantity absorbed in unit time is greater.

3. In two digestions carried on side by side for some time, one being supplied continuously with oxygen and the other deprived of it, the former produced most alcohol.

If the decomposition of the sugar had been the result of the respiratory activity of the yeast cells at the expense of the combined oxygen of the sugar, it would seem that fermentation should either not have taken place at all in the presence of free

oxygen, or that it should have been much less than in the other case, whereas the reverse is what is found. Hence Schützenberger advocated the view that the sugar is alimentary and not respiratory.

Certain facts more recently discovered support strongly the view that the nutrition of the yeast is the chief object of the process normally, though we cannot deny that when partial asphyxiation sets in fermentation is resorted to by the plant in its difficulty, that it may obtain the energy normally supplied by the respiratory processes. The mode of decomposition of the sugar, however, the formation of alcohol and carbon dioxide, raises a question as to the exact form in which the nutritive material is supplied to the protoplasm.

Of these more recent discoveries the work of Devaux on the trunks of trees may be mentioned first, as it seems to point to a similar problem to the one connected with yeast. Devaux examined the composition of the air in the interior of woody stems growing under normal conditions, and found that the proportion of oxygen it contains often sinks as low as ten per cent., while in a few cases, in the most internal part of the tree, he found this gas to be entirely absent. The disappearance of oxygen becomes easier with every increase of temperature. This partial asphyxiation is attended by the formation of alcohol in the struggling tissue, the spirit being detected by cutting up the branches of the trees and distilling them with a large excess of water. Devaux's experiments were made upon a considerable variety of trees, among which may be noted *Castanea vulgaris, Pyrus domestica, Alnus glutinosa, Ulmus campestris, Sambucus nigra* and *Ficus Carica.*

Similar results have been obtained by Mazé in some researches on seeds. When a number of these are submerged in water, microorganisms being properly guarded against, they do not readily germinate, but their weight nevertheless somewhat rapidly diminishes. In some of Mazé's experiments with peas he ascertained that this diminution was attended by a considerable formation of alcohol. Three parcels of forty peas were examined, weighing respectively 10, 17 and 27 grams, and the experiments lasted 6, 12 and 27 days. He found the proportion of alcohol to the original weight of the peas was 2.34, 4.63 and 6.56 per cent. As the peas were submerged, and so kept out of contact with air, it seems possible to suppose we have here again an effect of asphyxiation. Other experiments, however, make this view unsatisfactory. He germinated twenty peas at 22° C. for seven days under normal conditions, till their axes were about 1½ inches long. He then covered them with water, in some cases leaving the terminal bud exposed to air. The development of the submerged plants stopped at once, and at the end of five days the liquid contained 130 milligrams of alcohol. The seedlings whose terminal buds were exposed to the air continued to grow without showing any disturbance. Mazé concludes that the alcohol produced was utilized by them in their growth, and suggests that it is a normal and necessary product of the digestion of carbohydrate material in seeds in course of development.

He goes on to show that alcohol can be demonstrated to be present in plantlets that have germinated for forty-eight hours at 23° C. under normal conditions.

Another worker of great eminence who has found similar conditions to exist in normal vegetation is Berthelot. He put blades of wheat and leaves of the hazel in flasks, displaced the air by hydrogen, and distilled. In the case of the wheat he heated the flask to 94° C., in that of hazel he conducted the distillation by passing steam through the flask. In both he found

the distillate contained alcohol. The quantity was not large, but still measurable; from 10 kilos. of leaves he obtained 10 grams of alcohol.

Mazé claims to have found alcohol under normal conditions in the stems and leaves of the vine.

Mazé finds further that the weight of a seedling of maize approximates at any moment during the early stages of germination to half that lost by the reserve store in the endosperm.

From his experiments, and those of the other authors alluded to, he concludes that alcohol is formed in the living cells of seeds at the expense of grape sugar by virtue of a normal diastasic process, which makes them approach yeast cells more closely than has been suggested by any of the experiments hitherto published. We may inquire further how far the evidence points to the probability that the molecule of sugar is split up in that way into alcohol and carbon dioxide, and that the alcohol is the nutritive part of the sugar molecule. Certainly Mazé's experiments on the submerged seeds with the plumule exposed above the water are not inconsistent with that view. Duclaux has spoken more definitely still on this point, and has said that the alcohol formed becomes a true reserve material to be used for nutriment.

We have, however, further evidence that to some plants, at all events, alcohol is a food. Laborde has published some researches conducted upon a fungus, *Eurotiopsis Gayoni,* which point unmistakably to this conclusion. He cultivated it in a solution containing only the mineral constituents of Rawlin's fluid and a certain percentage of alcohol, usually from four to five per cent. The plant grew well, forming little circular patches of mycelium, which enlarged radially as the growth progressed. The mycelium became very dense in the center of the patches, and the fungus evidently thrived well. As it grew the alcohol slowly disappeared, the rate being about equal to that of sugar in a similar culture in which this substance replaced the alcohol. The mycelium in some experiments was cultivated quite from the spores. Eurotiopsis is a fungus which has the power of setting up alcoholic fementation in saccharine solutions. When cultivated in these alcohol is accordingly produced, and subsequently used, but the growth of the mold is not so easy under these conditions as when the alcohol is supplied to it at the outset.

Duclaux has shown that in the case of another fungus, the well-known *Aspergillus niger,* though alcohol kills it while it is in course of germination from the spore, it can utilize for nutrition 6.8 per cent. when it becomes adult, continuing to grow, and putting out aerial hyphæ. Eurotiopsis is more pronounced in its liking for alcohol, for it thrives in a mixture containing ten per cent.; even if submerged entirely it continues to grow and flourish in an eight per cent. solution.

The peculiarity relates only to ethyl alcohol; methyl alcohol will serve as a nutritive medium for only a little time, sufficient only for the commencing development of the spores into a mycelium and disappearing very slowly from the culture fluid. The higher alcohols, propyl, butyl and amyl, not only give no nourishment, but are poisonous to spores. A very small trace of any of them can be used by the adult mold.

Laborde claims to have established as the result of his investigations that Eurotiopsis normally makes alcohol from the sugar to nourish itself with it, just as yeast makes invert sugar from cane sugar because it is the nutritive material it likes best. The enzyme zymase is present in the fungus and plays the part of an alimentary enzyme. Its consumption lasts twice as

long as that of a corresponding weight of glucose; it can serve twice as long for the nutrition of the same weight of plant.

These remarkable results lead us to the consideration of the mode in which the carbohydrates, and particularly the sugars, are assimilated by the plant. We have held the view that the sugar molecule is capable of entering with little if any alteration into that of protoplasm. We have found no direct evidence bearing upon its fate. It is possible to detect sugar in the axis of a plant till quite near its growing point. Then the reaction ceases to be obtainable, and we know that assimilation is taking place. But we have still to investigate the steps, no very easy problem to undertake. May it possibly be that it is the alcohol moiety of the sugar which the protoplasm takes up, part of the carbon dioxide evolved by the growing organ being an expression, not of respiration, but of a fermentation preliminary to assimilation?

But I feel I have dealt at sufficient length with this question. I pass, therefore to consider briefly another nutrition problem of a rather different kind. The germination of seeds is a question that might be thought to have been fairly settled by the investigations of the latter half of the last century. We have come to the conception of the seed as fundamentally a young embryo lying quiescent within its testa, and provided with a store of nourishment deposited either within its own substance, or lying round it in the tissues vaguely named endosperm or perisperm. The nourishment has been held to be practically ready for its use, needing only a certain amount of enzyme action to be applied to it to convert the food store from the reserve to the nutritive condition. We have recognized here starch, proteids and glucosides, and have ascertained that the embryo can furnish the appropriate enzymes for their digestion. Each reserve store has apparently been quite independent of the rest, and the embryo has had control of the whole.

Certain considerations, however, lead us to the view that for albuminous seeds at any rate this mode of looking at the matter is no longer satisfactory. We may first ask how far the embryo is the controlling factor in the digestion. Putting the matter in another form, is the influence of the parent plant lost when a stable store of food has been provided for the offspring, and does it leave its utilization entirely to the latter? Is the gametophyte prothallus merely to become a dead or inactive structure as soon as it has developed its young sporophyte, or may its influence extend for the longer period of germination? There are many reasons for thinking this is the case. Indeed the view has been put forward by some observers at intervals for some years. Gris claimed to have shown it in 1864; but it was opposed by Sachs, who said that the enzymes which cause decompositions in the reserve materials are always formed in the young plant or embryo and are excreted by the latter into the endosperm. Some careful experiments on the point were conducted by Van Tieghem and were published by him in 1877. His work was carried out on the seeds of the castor-oil plant. He deprived the seeds of their embryos and exposed them for some weeks on damp moss to a temperature of 25–30° C. After several days of this exposure he found the isolated endosperms were growing considerably, and at the end of a month they had doubled their dimensions. In the interior of the cells he found the aleurone grains to be gradually dissolving, and the oily matter to be diminishing, though slowly. The dissolution extended throughout the mass of the endosperm, and was not especially prominent in the side that had been nearest to the cotyledons. He noted, too, that though starch did not normally appear in the germinating endo-

sperm, under the condition of non-removal of the products of the decomposition, it did appear in the cells in the form of small grains, though not till after several days had elapsed. Van Tieghem also observed that the progress of the decompositions could be arrested and the endosperms made to reassume a quiescent condition, and that then the aleurone grains again became formed, though in less quantity than before.

In some experiments on *Ricinus* which I carried out in 1889 I found much the same sequence of events as Van Tieghem had described. The endosperm unquestionably became the seat of a renewed metabolism, in the course of which many interactions between the various reserve materials became noticeable. It was remarkable that the activity of this metabolism was much more pronounced when the embryo or parts of it were left in contact with the endosperms.

An observation of a similar character has been made by Haberlandt and by Brown and Morris in the case of the seeds of grasses. The conversion of the reserve cellulose of barley grains has been shown by these observers to be the result of the action of an enzyme *cytase*, which is secreted largely by the so-called aleurone layer, which is found surrounding the endosperm, immediately underneath the testa.

Recently my own work has been bearing on this question, particularly as regards the behavior of the seeds of *Ricinus* during germination. The reserves of this seed are mainly composed of oil and aleurone grains, hardly a trace of carbohydrates being present. At the onset of germination there is a remarkable appearance of both cane sugar and glucose, which increase as the oil diminishes. The old view advanced to explain this fact has been the transformation of the oil directly into the sugars or one of them, a theory which it was difficult to reconcile with the chemical possibilities of oil. I have found that side by side with the appearance of the sugar we have also the formation of a considerable quantity of lecithin, a fatty body containing nitrogen and phosphorus. The seed contains a comparatively large amount of phosphorus in the form of the well-known globoids of the aleurone grain, a double phosphate of calcium and magnesium. The occurrence of this body points to a considerable interaction of various substances existing in the seeds, the phosphorus apparently coming from the globoids and the nitrogen from the proteids. Instead therefore of the fat being transformed into sugar it seems certain that a very considerable metabolism is set up, in which the various constituents of the endosperm interact very freely together. I am informed by Mr. Biffin, who has investigated the histological changes accompanying the germination, that the protoplasm of the endosperm cells appears to increase in amount very greatly during the early stages. The observations suggest a very vigorous resumption of metabolic activity by the cells of the endosperm, in the course of which the various reserves are brought into relation with the living substance of the cells and a number of new products are formed to minister to the nutrition of the growing embryo. The formation of the sugars may more probably be referred to the renewed activity of the protoplasm of the parent gametophyte than to a direct transformation of the fat under the influence of the embryo. Further researches upon a large variety of seeds appear necessary to give us a true idea of the chemical processes of germination. What now appears probable in the case of fatty seeds may prove to be true also in the case of those which have other varieties of reserve material.

I have already alluded to the problems concerning the electrical phenomena pre-

sented by the plant at rest and during activity. Very little work has so far been done in this direction, and our knowledge of the subject is materially less than that concerning similar phenomena in muscle and nerve. Still a beginning has been made, and we have observations on record due to Waller and to Bose which are of the greatest interest, not only because they show a great correspondence in behavior between animal and vegetable structures, but on account of their possible importance in determining the character of many of the metabolic processes and the forces at work in the tissues.

Some very striking results were only a few months ago published by Bose on the electric response in ordinary plants to mechanical stimulation. He arranged a piece of vegetable substance, such as the petiole of the horse-chestnut, or the root of a carrot or a radish, so that it was connected with a galvanometer by two non-polarizable electrodes. The uninjured tissue gave little or no evidence of the existence of electrical currents; but if a small area of its surface was killed by a burn or the application of a few drops of strong potash, a current was observed to flow in the stalk from the injured to the uninjured area, just as is the case in animal tissue. The potential difference in a typical experiment amounted to .12 volt. The tissue was then stimulated, either by tapping or by a torsion through a certain angle, and at once a negative variation or current of action was indicated, the potential difference being decreased by .026 volt. Very soon after the cessation of the stimulus the tissue recovered and the current of rest flowed as before. Bose's investigations extended considerably beyond this point, and established a very close similarity in behavior between the vegetable substance and the nerves of animals. Summation effects were observed, and fatigue effects demonstrated, while it was definitely shown that the responses were physiological. They ceased entirely as soon as the piece of tissue was killed by heating.

This remarkable demonstration of similar electrical properties to those possessed by nerve strengthens very greatly the view of the conduction of stimuli in the plant by means of the protoplasmic threads which have been demonstrated by Gardiner and others to exist throughout the plant, uniting cell to cell into one coherent whole.

Much remains to be done in this field; indeed, not more than a beginning has been made. The electrical accompaniments to response to stimuli have been investigated by Burdon Sanderson in the case of *Dionæa,* but many other instances are still awaiting examination. The peculiar phenomena of electrotonus and their relation to stimulus have so far only been observed in animals.

These observations strengthen considerably the view of the identical nature of animal and vegetable protoplasm which has in recent years come into prominence, and which is receiving more and more support in all directions.

These electrical currents, following mechanical action, which no doubt is accompanied by chemical change, make us ask whether electrical phenomena do not in all probability accompany the slow chemical actions which we call metabolism. The view that electrical energy is concerned in the processes of photosynthesis, suggested in an earlier part of this address, is certainly not weakened by a consideration of these phenomena.

The probability of the transmission of stimuli through vegetable tissue along the protoplasmic threads, extending from cell to cell, has been supported during the last year or two by some remarkable observations claimed to have been made by Nêmec on certain roots and other organs. He says he has succeeded in demonstrating a

continuous fibrillar structure in the protoplasm of the cells, fibrils passing along it in a longitudinal direction and apparently connecting the protoplasm of a longitudinal series of cells into a conducting chain. These conducting strands extend between the sensitive region—*e. g.*, the tip of the root—and the region which is growing, and which is caused by the stimulus to curve. Nêmec says that these conducting strands can be made evident by the use of appropriate staining reagents. They vary in number and position, but appear to be confined to sensitive and motile organs.

It is clear that the matter cannot rest where it is. The statements made by Nêmec call for investigation by both histological and physiological methods. It is possible that appropriate reagents may lead to the recognition of structure in what has been hitherto regarded as undifferentiated protoplasm.

Before concluding this address I may call attention to the vast field opening up in connection with the pathology of plants. The work done by our predecessors has been more largely work on the morphological peculiarities of various fungi than upon the physiological changes which constitute pathology, properly so called. It is only recently that attention has been given to the broad questions of disease in plants. Even now, however, certain advances have been made, and the direction of research is taking shape. In the science of pathology little in recent years has been so fascinating as the question of immunity against the attacks of certain diseases, either hereditary or acquired. It has been bound up with the very large question of toxins and their attenuation, their opposites, the antitoxins and matters of a similar nature.

Great results have been obtained in human pathology, with which it is not for me to deal. I mention them here because we are face to face with the possibility of treating some of the diseases of plants in a similar way, and perhaps on the threshold of very far-reaching discoveries.

I may call attention to the researches of Ray and of Beauverie upon the general question of plant infection, and especially upon a disease set up by a fungus known as *Botrytis cinerea* which attacks grapes, begonias, and other plants. The fungus exists in three forms, one of which is a harmless saprophyte, another a destructive parasite, and a third intermediate between the two. The first is a very common fungus, developing on decaying plants and bearing ordinary gonidia or spores. The second is completely filamentous and bears no reproductive organs. It is produced when the air is heavily charged with moisture and the temperature high, conditions of common occurrence in forcing houses. The third is an attenuated form intermediate between the other two. It bears gonidia like those of the first, and in addition others which germinate without falling off the parent plant and elongate into threads. Many plants can bear the invasion of this plant without suffering greatly, though it cannot be called harmless. It occurs chiefly when a high temperature is associated with a considerable amount of moisture in the air.

It is not difficult to cultivate this attenuated form of the *Botrytis* in sterilized soil. Beauverie describes one experiment made with it which is very striking. Damp earth was sterilized in a Petri dish of large surface, sown with spores of the *Botrytis,* and kept at a temperature of about 16° C. After three days the surface of the dish was covered with a loose mycelium, which bore numerous gonidiophores. The fungus was allowed to grow for some time under these conditions, and the infected earth was then transferred to fresh pots in which were placed cuttings of begonias. The plants grew well and were

not sensibly affected by the presence of the fungus in the substratum or in its surface. Placed subsequently in conditions which were eminently suitable to the development of the parasitic form, they resisted its action perfectly, though control plants which had not been cultivated in the ground infected by the attenuated form were killed very quickly. From their experiments the authors claim to have shown that the form of *Botrytis cinerea* intermediate between the gonidial and the sterile form can make plants immune to the attacks of the latter.

Researches of a somewhat kindred nature dealing with the infection of particular plants by specific fungi have been communicated recently to this section by Professor Marshall Ward in his paper read last year on the bromes and their brown rust. They brought to light many very important facts connected with the question of adaptive parasitism and immunity. Few questions in vegetable physiology can compare in economic importance with these when we think of their possible development in relation to agriculture.

I have now somewhat hurriedly surveyed certain parts of the field of vegetable physiology. It has been impossible in an address like this to do more than indicate what seem to me some of the more important problems awaiting investigation. May we hope that all such work will be vigorously conducted, but that the conclusions reached will be scrutinized with the greatest care and subjected to repeated examination? Great hindrances to the advance of the science resulted from dogmatic assertions made by eminent men in the past, their personal influence having led to their conclusions, not altogether accurate, being nevertheless almost universally accepted. Many years subsequently these conclusions have needed reexamination, the result being the destruction of a whole fabric that had been reared upon this unworthy foundation. I may close, as I began, by an appeal to the younger school of botanists to take some of this work in hand, and by assiduous and critical experiment and observation to contribute to the solution of the problems pressing upon us in this field.

J. Reynolds Green.

Cambridge University.

American Ornithologists' Union.

The Twentieth Congress of the American Ornithologists' Union convened in Washington, D. C., Monday evening, November 17. The business meeting of the fellows was held at Dr. Merriam's residence, and the public sessions, commencing Tuesday, November 18, and lasting three days, were held at the U. S. National Museum.

Dr. C. Hart Merriam, of Washington, D. C., was reelected president; Charles B. Cory, of Boston, and C. F. Batchelder, of Cambridge, Mass., vice-presidents; John H. Sage, of Portland, Conn., secretary; William Dutcher, of New York City, treasurer; Frank M. Chapman, Ruthven Deane, E. W. Nelson, Witmer Stone, Drs. A. K. Fisher, Jonathan Dwight, Jr., and Thos. S. Roberts, members of the Council.

The ex-presidents of the Union, Dr. J. A. Allen and Messrs. William Brewster, D. G. Elliot and Robert Ridgway, are *ex-officio* members of the council.

Harry C. Oberholser, of Washington, D. C., was elected a fellow; Ernst Hartert, of England, and John A. Harvie-Brown, of Scotland, honorary fellows; A. J. Campbell, of Melbourne, W. P. Pycraft, of London, Dr. H. von Ihering, of Brazil, and Alfred J. North, of Sydney, N. S. W., corresponding fellows. Thirteen associates were elected to the class known as members, and eighty-four new associates were elected.

Mr. Witmer Stone, in his paper entitled 'A Glance at the Historical Side of the Check-List of North American Birds,' referred to the help accorded by the earlier ornithologists in making a check-list possible, and gave in detail the number of species described by each. Dr. Allen traced the history of the present A. O. U. check-list from its inception and spoke of its future.

Much discussion ensued and many inquiries were made regarding the protection of birds. The report of the committee having this matter in charge showed that satisfactory results had been obtained during the past year, and that interest in the preservation of wild bird life was not lacking at the present time. Dr. Bishop spoke of the slaughter by marketmen and milliners' agents of the species found along the coast of North Carolina, and Mr. Dutcher remarked on the proposed legislative bills for the preservation of such birds. Dr. Palmer told of the immense number of ducks annually taken to the northern markets from the North Carolina coast. He thought the upland as well as the shore birds needed protection. Professor T. Gilbert Pearson referred to the destruction of bob-white in his state (North Carolina), and of the illegal methods used in transporting them north.

Mr. Chapman compared the bird-life of Gardiners Island, N. Y., and Cobbs Island, Va., accompanying his remarks with lantern slides. As a result of rigid protection birds are abundant on the former island, while at the latter island, for want of suitable protection, they are nearly exterminated.

Mr. George Spencer Morris gave many facts relating to the life of Edward Harris, the friend of Audubon, and read extracts from his unpublished journals. It was an important contribution to the historical side of ornithology.

The Union sustained a severe loss in the death of Major Jas. C. Merrill, U. S. A., a prominent fellow of the Union, who died in October, and of Chester Barlow, a member, who died the present month. Mr. Barlow was also the leading spirit in the Cooper Ornithological Club of California.

The day following adjournment the members of the Union were invited by the Secretary of the Smithsonian Institution to visit the National Zoological Park, and many availed themselves of the privilege. Secretary Langley received the visitors, who were subsequently taken through the Park by Dr. Frank Baker, the Superintendent.

The question of holding a special meeting of the Union in California the coming year was referred to a committee, with power.

Following is a list of the papers read at the sessions:

GEO. SPENCER MORRIS: 'Notes on the Life of Edward Harris, with Extracts from his Journals.'

HUBERT LYMAN CLARK: 'The Development of the Pterylosis.'

JOHN N. CLARK: 'The Domestic Affairs of Bob-white.'

T. GILBERT PEARSON: 'Summer Bird Life of Eastern North Carolina.'

R. M. STRONG: 'Change of Color without Molt.'

R. M. STRONG: 'Iridescence and White Feathers.'

WALTER B. BARROWS: 'Some Problems of Local Bird Population.'

T. S. ROBERTS: 'Notes on *Picoides Americanus* and *Picoides arcticus* in Minnesota.' Illustrated with lantern slides.

FRANK M. CHAPMAN: 'Comparison of the Bird Life of Gardiners Island and Cobbs Island.' Illustrated with lantern slides.

W. L. BAILY and WM. DUTCHER: 'A Contribution to the Life History of the Herring Gull.' Illustrated with lantern slides.

J. A. ALLEN: 'The A. O. U. Check-List—its History and its Future.'

WITMER STONE: 'A Glance at the Historical side of the Check-List of North American Birds.'

E. W. NELSON: 'Evolution of Species and Subspecies as illustrated by certain Mexican Quails and Squirrels.'

H. W. Olds: 'Form in Bird Music.'

F. A. Lucas: 'Ancient Birds and their Associates.' Illustrated with lantern slides.

Paul Bartsch: 'Observations on the Herons of the District of Columbia.' Illustrated with lantern slides.

Frank M. Chapman and Louis Agassiz Fuertes: 'Bird Life in the Bahamas.' Illustrated with lantern slides.

Wm. Dutcher: 'Report of the Chairman of the Committee on the Protection of North American Birds.'

T. S. Palmer: 'Federal Game Protection in 1902.'

Jonathan Dwight, Jr.: 'Some Variations in the Piping Plover.' (*Ægialitis meloda.*)

Wm. H. Fisher: 'Nesting of the Red-bellied Woodpecker in Harford County, Maryland.'

B. S. Bowdish: 'Some Food Habits of West Indian Birds.'

Witmer Stone: 'The Significance of Trinomials in Nomenclature.'

Elon Howard Eaton: 'An Epidemic of Roup in the Canandaigua Crow Roost.'

The next annual meeting will be held at the Academy of Natural Sciences, Philadelphia, commencing November 16, 1903.

John H. Sage,
Secretary.

*A GRADUATE SCHOOL OF ENGINEERING RESEARCH.**

In the charter granted to the incorporators of the Institute of Technology forty-one years ago, they and their successors were made a body corporate for the purpose of instituting a society of arts, a museum of arts, and a school of industrial science. In addition the purpose and aim of the corporation was then declared to be to aid 'generally by suitable means the advancement, development and practical application of science in connection with arts, agriculture, manufacture and commerce.'

This intention to advance and to develop the practical applications of science has been steadily kept in view, and the corporation and faculty of the Institute have striven constantly, in the four decades of its history, to advance the quality of instruction and to enlarge the facilities for laboratory practice. The curriculum of studies offered to undergraduate students of the Institute has gradually changed with the growing demands of the industrial life of the country. New engineering courses have differentiated themselves from those originally established. At its foundation the Institute offered but three distinct courses for engineers—civil, mechanical and mining engineering. To-day it offers, in addition to these, courses in electrical engineering, chemical engineering, sanitary engineering and naval architecture; and in several of these branches applications of science are employed which forty years ago were unknown. Thus biology brings to the aid of the sanitary engineer to-day a technical knowledge absolutely essential in his profession which was impossible forty years ago.

The demands of modern civilization call for engineers who can do more than keep abreast of the theory and practice of their profession. They must be able to solve new problems and to advance the state of the art in which their work lies. In applied science no less than in pure science there is need for research and for the development of the research spirit. Problems of immense practical importance are pressing for immediate solution. Such questions as the cheapening of electric power, the problem of long-distance transmission, the purification of streams and the sanitary engineering of great cities, the numerous applications of chemical engineering to the arts, furnish numerous problems of investigation whose solution affords at once the keenest intellectual exercise and the most practical and useful results. The larger industrial and manu-

* Extract from an announcement about to be issued by the Massachusetts Institute of Technology.

facturing establishments are themselves conducting independent laboratories of research, and there is an increasing demand for men who have not only the training of the technical school, but the attitude of mind to attack new problems; men who have not simply a basis of theoretical and practical knowledge to begin research, but who have the spirit of research as well.

This demand for research in engineering and for men capable of undertaking such work has long been recognized, and the Institute has for some years looked toward the inauguration of a department of engineering research. The installation this year of the Lowell Electrical Engineering laboratories, with the additional facilities which are thus offered, makes the present an opportune time to undertake this work. A graduate school of research will therefore be established as a distinct department of the Institute immediately after the opening of the next academic year—namely, on October 7, 1903—under conditions which are given in the announcement that will be issued.

An examination of these conditions will make it clear that the intention of the authorities of the Massachusetts Institute of Technology is to provide in the Graduate School of Engineering Research facilities for a small number of advanced students who show capacity for research.

The administration of the School is vested by the corporation and faculty in a council of members of the faculty, including the president as chairman.

The staff will consist of professors and instructors of the Institute and other persons actually engaged in engineering enterprises.

Opportunities for advanced study and research will be provided in the following branches of engineering:

Civil Engineering.
Sanitary Engineering.
Mechanical Engineering.
Electrical Engineering.
Naval Architecture and Marine Engineering.
Mining Engineering and Metallurgy.
Chemical Engineering and Industrial Chemistry.

In these subjects the degree of Doctor of Engineering (Eng. Dr.) will be awarded. As heretofore, the Institute will offer courses of advanced study and research in pure science—*e. g.*, mathematics, mechanics, physics, chemistry, biology and geology—leading to the degree of Doctor of Philosophy (Ph.D.). These advanced courses will be open also to students of engineering research.

SCIENTIFIC BOOKS.

DR. MEYER ON SOME EUROPEAN MUSEUMS.

PENDING the publication of the final part of his memoir on the museums of the eastern United States, Dr. A. B. Meyer has given us the results of his observations on some of the museums and other educational institutions of Great Britain and eastern Europe. These were visited in order to make comparisons between them and similar institutions in America, and to gather all possible information regarding museum buildings and installation. The present paper deals especially with the three great problems of light, heat and ventilation which confront the architect of every large museum, although the reader will find information on all points of interest. The complaint is made that many desired illustrations were not to be had, and it has been suggested that the present demand for the illustrated postal card has much to do with the lack of good-sized photographs of many important buildings.

In regard to lighting Dr. Meyer is emphatically of the opinion that the proper method is by side windows and preferably by windows on both sides of exhibition halls, in order to check the reflection from the glass of cases standing in shadow. The most customary method of lighting is by overhead skylights, in order to gain wall space, but while this is well enough for a single floor, when one or two galleries are introduced it

naturally results in poor illumination beneath portions of these, and the only way to do away with such dark corners is by side windows. The defects of overhead light are shown in the Edinburgh Museum of Science and Art, and in the Museum of the Royal College of Surgeons, London, although the same system is retained in a recent addition in order to preserve uniformity of architecture.

The problems of ventilation and heating are considered in various places and the palm awarded to the Glasgow Museum and the Free Public Museum of Liverpool, which, Dr. Meyer emphatically declares, 'excel all other museums in the world in respect to the method of heating and ventilating.' Curiously enough, while these two institutions were under construction practically at the same time, neither was aware that the same system of ventilation had been adopted by the other. In these two museums the air is drawn in through a large air shaft, six by nine feet, filtered, warmed and forced into the buildings by large blowers. The windows are permanently closed and the pressure of air within kept at a higher point than that of the outside air, so that dust is not sucked in through doors or other unavoidable openings. In some other museums the windows are kept closed and the air more or less cleansed as it is drawn into the buildings, but none of the devices adopted is so efficient as that employed at Glasgow and Liverpool, known as 'Keys improved Plenum method.'

Dr. Meyer frequently calls attention to the fact that too often the exterior of a museum is designed without reference to the interior, when the proper method to be followed is quite the reverse of this, and that the arrangement of the exhibition halls and offices should be decided first and the exterior adapted to them. In regard to these same exteriors the illustrations show a great diversity of style and various attempts to combine architectural effect with room and light. One of the least successful of these architecturally seems to be the new museum at Brussels, although this may perhaps be compensated for by the abundance of light in the exhibition halls, while the most successful, judging by the illustrations, is the Liverpool Free Museum. This, however, is probably because there is no view of the new Galleries of Comparative Anatomy and Anthropology at Paris, whose architectural features and harmonious methods of installation elicit the warmest praise, with the exception of the fern leaf decoration of the balcony rails. These are said to be over-ornamented to such an extent as to be obtrusive, a feature that will perhaps be toned down by age.

The pure Gothic style so often adopted results in gloomy interiors, but the author calls attention to the fact that the modified gothic, such as is used in the University of Chicago, may be successfully employed. In connection with the subject of architecture something might well have been said of museum cases, for architects are responsible for many failures in this direction, and few of them are competent to plan even a moderately good case.

Dr. Meyer is evidently of the opinion that most museums are too freely open to visitors, objects on exhibition being ruined by long exposure to light, although the Paris museums of natural history go the other extreme and are open for so short a time that it is difficult to properly examine the collections. Here he touches upon a difficult problem in administration and one which is particularly so in the United States, where the tendency is to extend, rather than curtail the hours of exhibition. In many ways it seems best to submit to the inevitable, and, after taking every possible precaution to so admit the light that it may be diffused, admit the public as freely as possible. The rarer objects might be withheld from exhibition or displayed only on certain days or hours, while the more common objects could be replaced. Few, if any, museums now place their types of birds or mammals on exhibition, and the question of showing large mammals and rare birds is becoming serious in view of the destruction now going on.

Another point incidentally touched on in this paper is what may be termed the over-exhibition of specimens, the display of so

large a number that the visitor is simply bewildered and but little interested or instructed. And this point is well made, for there is not the slightest doubt that a limited number of specimens, well installed and properly labeled, is in every way better than the large series so often shown. The arrangement of natural history collections on a geographical basis is also dwelt on in various places, and this has always seemed to the present writer the best method by far. The prediction is here ventured that the successful museum of the future will, so far as the exhibition of biological material is concerned, consist of a central synoptic or index collection, supplemented by series displaying the geographical and geological distribution of plants and animals, and various features in their life histories. This by no means precludes the display of systematic series wherever this may be thought desirable, but this feature of museums is commonly made far too much of. The exhibition series of a museum is for the public, and the average visitor does not go to the museum for study, and the advanced student does not, as a rule, seek for information in the material on exhibition, although there are notable exceptions to this rule in anthropological collections.

In the department of anthropology, by the way, Dr. Meyer does not favor a geographical arrangement, but advocates bringing together all objects of a kind in order that their development and variation may be seen. Where space and material admit, however, he considers that there should also be geographical series to illustrate the customs of different races. In respect to installation, the Pitt-Rivers Museum at Oxford is awarded the first place among English ethnological museums and the scheme of its arrangement is given in full.

A detail of installation, shown in many of the illustrations, is the large number of skeletons on exhibition with no protection whatever from dust or visitors, and one can but think that either the attendants are more vigilant abroad than here or the visitors more conscientious. Specimens so recklessly displayed in this country would run great chance of being ruined by dust, or of being broken by relic-seeking visitors; no specimen that can possibly be put in a case should be exposed.

Some of the shortcomings of museums are, however, unavoidable, while others, as Dr. Meyer is careful to say in his introductory remarks are 'to a greater extent the fault of the establishment than of the persons in charge, for one individual has little control of the many circumstances on which the historical development of museums and other institutions depends.' It is to be hoped that Dr. Meyer may soon be able to embody his views regarding museums in the construction of a new museum in Dresden, but we trust he will not wait until that time to give us a summary of these views, and possibly he may present them in his next paper.

F. A. L.

SCIENTIFIC JOURNALS AND ARTICLES.

IN *The American Naturalist* for November Bashford Dean presents the 'Biometric Evidence in the Problem of the Paired Limbs of the Vertebrates,' concluding that it is in favor of the fold theory and against the hypothesis that the limbs are modified gill arches. C. R. Eastman gives a 'Notice of Interesting Forms of Carboniferous Fish Remains,' and Lætitia M. Snow considers 'The Microcosm of the Drift Line,' being a discussion of the life relations of the insects found along the shores of Lake Michigan. Joseph A. Cushman gives 'Studies of Localized Stages of Growth in Some Common New England Plants' and H. S. Pratt under 'Synopses of North American Invertebrates,' continues the treatment of the Trematodes, the first part of which appeared in the *Naturalist* for August, 1900. The number contains the 'Quarterly Record of Gifts, Appointments and Deaths.'

The Popular Science Monthly for December opens with an article by David Starr Jordan on 'The Higher Education of Women,' which concludes with the statement that coeducation is never a question where it has been tried. W. P. Pycraft tells of 'The Significance of the Condition of Young Birds

at Birth,' considering that the facts justify the belief that early birds were arboreal and nidifugous. C. K. Edmunds discusses 'The Motive Power of Heat.' There is a reprint of Francis Bacon's 'Solomon's House,' and J. G. Lipman writes of 'Nitrogen-fixing Bacteria,' indispensable factors in the production of the world's food. S. C. Cronwright Schreiner describes 'Some Arachnids at Hanover, Cape Colony,' giving many interesting details of their habits; and in 'Zoology in America' T. D. A. Cockerell gives a brief résumé, based on titles in the *Zoological Record* of the scientific work being done here. He concludes that if we are not doing what we might and ought, we are not so seriously behind. In the fourth of his articles on 'Mental and Moral Heredity in Royalty,' Frederick A. Woods considers the rulers of Spain and, lastly George B. Hollister has an article on 'The Size of Alaska.'

Messrs. Borntraeger, Berlin, announce the publication, beginning with January 1, of a bi-weekly *Biochemische Centralblatt* under the charge of leading German students of biochemistry.

SOCIETIES AND ACADEMIES.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The fifty-second annual meeting of the American Association for the Advancement of Science, and the first of the Convocation Week meetings, will be held in Washington, D. C., December 27, 1902, to January 3, 1903. The retiring president is Professor Asaph Hall, U.S.N., and the president elect, President Ira Remsen, Johns Hopkins University. The permanent secretary is Dr. L. O. Howard, Cosmos Club, Washington, D. C., and the local secretary, Dr. Marcus Benjamin, Columbian University, Washington, D. C. President Roosevelt is honorary president of the local committee. The preliminary program with information in regard to hotel headquarters, railway rates, etc., will be found in the issue of Science for November 21. The following scientific societies will meet at Washington in affiliation with the Association:

The American Anthropological Association will hold its first regular meeting during Convocation Week in affiliation with Section H of the A. A. A. S. President, W J McGee; secretary, George A. Dorsey, Field Columbian Museum, Chicago, Ill.

The American Chemical Society will meet on December 29 and 30. President, Ira Remsen; secretary, A. C. Hale, 352A Hancock street, Brooklyn, N. Y.

The American Folk-lore Society will meet in affiliation with Section H of the A. A. A. S. President, George A. Dorsey; vice-presidents, J. Walter Fewkes, James Mooney; secretary, W. W. Newell, Cambridge, Mass.

The American Microscopical Society will probably hold a business meeting on December 29. President, E. A. Birge, Madison, Wis.; secretary, H. B. Ward, University of Nebraska, Lincoln, Nebr.

The American Morphological Society will meet on December 30 and 31. President, H. C. Bumpus; vice-president, G. H. Parker; secretary and treasurer, M. M. Metcalf, Woman's College, Baltimore, Md.

The American Philosophical Association will meet on December 30 and 31 and January 1. Secretary, H. N. Gardiner, Northampton, Mass.

The American Physical Society will meet in affiliation with Section B of the A. A. A. S. President, Albert A. Michelson; secretary, Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Physiological Society will meet on December 30 and 31. President, R. H. Chittenden; secretary, F. S. Lee, Columbia University, New York, N. Y.

The American Psychological Association will meet on December 30 and 31 and January 1. President, E. A. Sanford; secretary and treasurer, Livingston Farrand, Columbia University, New York, N. Y.

The American Society of Naturalists will meet on December 30 and 31. President, J. McK. Cattell; vice-presidents, C. D. Walcott, L. O. Howard, D. P. Penhallow; secretary, R. G. Harrison, Johns Hopkins University, Baltimore, Md.

The Association of American Anatomists will meet on December 30 and 31. President, G. S. Huntington; vice-president, D. S. Lamb; secretary and treasurer, G. Carl Huber, University of Michigan, Ann Arbor, Mich.

The Association of Economic Entomologists will meet on December 26 and 27. President, E. P. Felt; secretary, A. L. Quaintance, College Park, Md.

The Astronomical and Astrophysical Society of America will meet during Convocation Week, in affiliation with Section A of the A. A. A. S. President, Simon Newcomb; secretary, George C. Comstock, University of Wisconsin, Madison, Wis.

The Botanical Society of America will meet on December 31 and January 1. President, B. T. Galloway; secretary, D. T. MacDougal, New York City.

The Botanists of the Central and Western States will meet on December 30. Committee in charge of the meeting, John M. Coulter, University of Chicago; D. M. Mottier, University of Indiana, Bloomington, Ind.; Conway MacMillan, University of Minnesota, Minneapolis, Minn.

The Geological Society of America will meet on December 29, 30 and 31. President, N. H. Winchell; vice-presidents, S. F. Emmons, J. C. Branner; secretary, H. L. Fairchild, University of Rochester, Rochester, N. Y.

The National Geographic Society will hold a meeting during Convocation Week. President, A. Graham Bell; vice-president, W J MeGee; secretary, A. J. Henry, U. S. Weather Bureau, Washington, D. C.

The Naturalists of the Central States will meet on December 30 and 31. Chairman, S. A. Forbes; secretary, C. B. Davenport, University of Chicago, Chicago, Ill.

The Society of American Bacteriologists will meet on December 30 and 31. President, H. W. Conn; vice-president, James Carroll; secretary, E. O. Jordan, University of Chicago, Chicago, Ill.; council, W. H. Welch, Theobald Smith, H. L. Russell, Chester, Pa.

The Society for Plant Morphology and Physiology will meet during Convocation Week. President, V. M. Spalding; vice-president, B. D. Halsted; secretary and treasurer, W. F. Ganong, Smith College, Northampton, Mass.

The Society for the Promotion of Agricultural Science will meet during Convocation Week. President, W. H. Jordan; secretary, F. M. Webster, Urbana, Ill.

The Zoologists of the Central and Western States will meet during Convocation Week. President, C. B. Davenport, University of Chicago.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 360th meeting was held Saturday evening, November 15.

M. B. Lyon exhibited some photographs of bats, one of a specimen of *Lasiurus borealis* with four young attached and one of *Dasypteris intermedius* showing two mammæ on one side. These examples, and others that had been dissected, showed conclusively that the commonly accepted statement that bats usually bore but one young was incorrect.

Charles Louis Pollard spoke on 'Some Aspects of the Flora of Cuba,' illustrating his remarks with lantern slides showing the characteristics of the flora near the coast and at different localities in the interior.

Under the title 'Stages of Vital Motion' Mr. O. F. Cook presented a discussion of evolutionary factors, in which it was held that evolution, or the progressive change in groups of organisms, is not primarily due to segregation, but to the normal accumulation of variations by cross-fertilization. Conditions most favorable to evolutionary progress are found in large and widely distributed natural species, narrow in-breeding and wide cross-breeding tending alike to a decline of reproductive fertility and to the production of abnormally abrupt variations, indicating a so-called catalytic or declining stage of evolution. Between the catalytic stage and the normally progressive or prostholytic stage there is, on the side of in-breeding, the hemilytic or retarded stage marked by relative uniformity, and, on the side of cross-breeding, a dialytic or divergent stage in which the characters of the parents are not permanently combined in the offspring but, as shown by Mendel, tend to separate again on the lines of the evolutionary motion of the parental types. The paper will appear in full later.

F. A. LUCAS.

BOTANICAL SOCIETY OF WASHINGTON.

THE ninth regular meeting of the Botanical Society of Washington was held at the Portner Hotel, October 25, 1902. The principal paper of the evening was by Mr. O. F. Cook. on 'Evolution in Coffee; Mutations Described and a Cause Suggested.'

Coffee, the speaker stated, is the most important crop grown from seed for the seeds. It has been in cultivation about a thousand years, but the selection of varieties has not been practiced; nevertheless, sports or mutations are rather frequent, at least in the coffee

plantations of Guatemala. Where several such varieties from other parts of the world have also been tested, the new sorts offer great diversity in other respects, but agree in being less fertile than the parent stock in actual amount or weight of seeds. It seems reasonable to associate this relative or complete sterility with the fact that coffee has been unintentionally inbred, new regions having usually been stocked from single trees, and it is further noted that reproductive debility is a general characteristic of other inbred domestic plants and of the so-called 'sports' or 'mutations' which appear among them. In other words, it is suggested that both the sterility and the mutations may be due to the same cause, the absence of normal cross-fertilization. This interpretation accords with what has been called a kinetic theory of evolution under which evolution is viewed as a physiological as well as a morphological process.

The tenth regular, and second annual, meeting of the Botanical Society of Washington was held at the Portner Hotel, November 8, 1902, with President A. F. Woods in the chair. No regular program had been prepared, the evening being given over to the election of officers and the consideration of general business. The following officers were elected for the ensuing year: *President,* A. F. Woods; *Vice-president,* Frederick V. Coville; *Recording Secretary,* Charles L. Pollard; *Corresponding Secretary,* Herbert J. Webber; *Treasurer,* Walter H. Evans.

Herbert J. Webber,
Corresponding Secretary.

DISCUSSION AND CORRESPONDENCE.

THE GRAND GULF FORMATION.

To the Editor of Science: I am naturally much interested in the communication of Messrs. Smith and Aldrich in your issue of November 21, and, as in the main it confirms my earlier determinations, yet does not correctly state either my position or that of Dr. Hilgard in more recent publications, I venture to supplement it by some words of explanation.

The original complex included under the name of Grand Gulf by Hilgard in 1860 was heterogeneous, but, in the absence of paleontological data, it could not be in its several parts correlated with other beds of known age. This of course led to various, sometimes conflicting, estimates of its place in the column. Professor Hilgard's last characterization of it (*Am. Journ. Sci.,* 3d ser., XXII., p. 59) is as follows: 'Clearly the Grand Gulf rocks alone represent, on the northern borders of the Gulf, the entire time and space intervening between the Vicksburg epoch of the Eocene and the stratified (Quaternary) drift.' We now call the Vicksburgian 'Oligocene,' so it is hardly fair to represent Dr. Hilgard as referring the Grand Gulf *at present* to the Eocene. Neither have I 'referred it' at different times 'to the Eocene, the Oligocene and the Miocene.' By means of paleontological data which have come in from time to time during the seventeen years I have been at work on our southeastern Tertiary, and to which no one has been more active in contributing than Professor Smith and Mr. Aldrich, I have been enabled to fix the age of *different portions* of the original heterogeneous series, as uppermost Oligocene (transitional) and Chesapeake Miocene, which is fully confirmed by the facts now cited by your correspondents. But there are still considerable portions which have yielded no fossils, and the age of which can only be inferred from their position in relation to other beds of known age. In 1898 ('Fifteenth Annual Report U. S. Geol. Survey,' part II., p. 340 and table) I was obliged to decide on some portion of the original Grand Gulf which should continue to bear the name, after deduction of beds of which the age had been determined, and fixed upon the Oligocene clays containing lignite and fossil palm leaves, the only fossils cited by Hilgard in his original description; and in my table of Tertiary horizons referred to them as 'Typical Grand Gulf.' The beds which Messrs. Smith and Aldrich call 'Grand Gulf' in their communication to Science are not the same, but are the non-fossiliferous upper portion at the other end of Hilgard's Grand Gulf section. I have

little doubt that their assumption as to the late, possibly Pliocene, age of these beds is correct, though it can only be proved by further and paleontological evidence, but this decision is merely an equivalent of the ideas above cited from Hilgard, and therefore not new.

That the Pascagoula horizon is Miocene rather than Pliocene is probable from the character of its scanty fauna, which is not of the sub-tropical type of the Pliocene of our southern coast, but indicates a cooler temperature, such as prevailed during the Miocene of that region.

The very great difficulties which the southern coastal plain offers to geological study are sufficient excuse for the slow progress which has been made, but it cannot be too often emphasized that no determination of the age of its beds not based on their fauna, or the fauna of beds both above and below those in question, can be regarded as more than tentative; and such determinations in the past have almost invariably proved erroneous.

WM. H. DALL.

THE SQUIDS FROM ONONDAGA LAKE, N. Y.

A FEW days since the newspapers told a story of how a citizen of Syracuse, while drawing a net in Onondaga Lake, got a strange looking fish, which upon being brought to Professor John D. Wilson, a well-known teacher of science in the city, was pronounced a squid. Professor Wilson has followed up this discovery, lest perchance some one connected with the affair were not too wise to be mistaken or too honest to deceive, and he assures me that he and his scientific friends are satisfied of the genuineness of this find. Professor Wilson learned from Mr. Terry, the discoverer, that he caught the creature in a net while fishing for minnows in shallow water. A second specimen was afterward found at the same place by a Mr. Lang who keeps a restaurant on the iron pier at the southeast corner of the lake. Both, as I understand, were caught alive. The first specimen was cooked (!) and then put in alcohol, the second is now in possession of the writer. The whole story makes a 'devilish fishy' first impression. Should there be no reason to doubt the verity of the discovery, its bearings are most suggestive. The place where the squids were found, Professor Wilson says, is just where the first salt springs were discovered and the first salt made in the Syracuse region by the early settlers long before salt wells were bored. Onondaga Lake is a shallow body resting on the Salina shales and unquestionably receiving at all times a considerable amount of saline seepage from the rocks below; for all we know to the contrary its bottom layers may be decidedly saline. These squids are not to be at once cast out as a 'fake' simply because they are marine animals alleged to have been caught in a fresh-water lake. Too many similar occurrences are known at the present to justify such procedure. There was a time in post-glacial history when there was communication from this body of water to the sea by the way of the St. Lawrence valley. It is within the limits of possibility that at such a time marine animals entered the present basin of Onondaga Lake as they did that of Lake Champlain, and that the saline condition of the lake waters has permitted their existence till the present. If such a presumption can be verified it will be by additional discoveries of these creatures supplemented by expert zoological determination of the specific characters and possible variations of these specimens, so that this discovery may prove to have a very important paleontologic bearing. Professor Wilson calls attention further to the fact that there are several hotels about the edge of the lake from which oyster and clam shells are thrown into the lake waters, but it hardly seems that this fact opens a possibility for the introduction by this means of the eggs of one of our Atlantic squids into conditions which would permit of their hatching. There are a number of considerations to be carefully weighed before the genuineness of this discovery can be accepted; if it is the work of some wag, he has shown acuteness in selecting Onondaga Lake rather than any other of the lakes of New York state. As very much, perhaps all, will depend upon the determinations of the zool-

ogist, the specimen in my hands will be turned over for examination to an expert.

John M. Clarke.

SHORTER ARTICLES.

PRELIMINARY RESULTS ON THE CHANGES OF ATMOSPHERIC NUCLEATION.*

1. Last May, Mr. Harvey N. Davis, at my request, put up an apparatus in this laboratory for counting the number of nuclei in the atmosphere by measuring the coronas producible with such air under appropriate conditions. The apparatus gave promise at once, but Mr. Davis was unexpectedly called away before the observations became fruitful and the project was temporarily abandoned. Believing that an instantaneous method of at least estimating the degree of atmospheric nucleation is a desideratum,† and must throw light eventually on the origin and character of the nuclei in the atmosphere, I have recently undertaken the work myself, and the results obtained in October, after the indications of the apparatus had become warrantable, are given below.

I may add that Mr. Davis, and later Mr. R. Pierce, Jr., had been at work for some time on the measurement of the daily variation of the solar constant (a project recently set on foot by the U. S. Weather Bureau) and that I hoped from a coordination of the two classes of data to reach conclusions of interest.

2. *Apparatus.*—The original apparatus was of an improvised kind, consisting of a large, horizontally placed aspirator flask or receiver (about 10 liters in capacity, 30 cm. long and 20 cm. in diameter) in which the coronas were produced, an exhaustion reservoir and appurtenances. Atmospheric air entered by a quarter-inch lead pipe, and after passing through a coil of pipe in a water-bath, kept at room temperature as shown by a thermometer, entered the receiver and was there saturated with water. Some of the nuclei may be absorbed in this necessarily long and thin influx pipe, though the tests made did not bear this out. At all events the absorption is proportional to the nucleation and will not affect the ratios of successive nucleations in the lapse of time which are here chiefly in question. In later experiments the receiver was replaced by a cylinder 50 cm. long and 15 cm. in diameter, the walls of which, in the absence of plate glass apparatus, produced less distortion. To measure the apertures of the coronas produced in the receiver, a horizontal goniometer was placed about one meter in front of it and the small circular source of light about two meters behind, all being at the same level.

3. *Method.*—It is necessary to take in the air at some feet from the laboratory; whenever the house is colder than the atmosphere, there is a draft outward and one is apt to catch the ventilation. The influx pipe must be scrupulously without leaks for the same reason.

Since coronas actually run as far as the green centered types, considerable variation is detected and a skilled eye may often dispense with the goniometer. For this reason distortion of the coronas due to the walls of the flask is of little consequence at the outset.

In the tables the date and hour, the aperture of the corona, the character of the weather and the temperature of the influx air were taken. From these, the number of nuclei, n, per cubic centimeter was computed. The measurements showed (if s is the chord of the aperture on the given goniometer),

$$d = .002/s \qquad (1)$$

in centimeters, where d is the diameter of the fog particle. At mean atmospheric temperature (21° C.) one may put $m = 79/10^9$ grams, as the moisture precipitated per cubic centimeter of air, for the pressure difference $\delta p = 17$ centimeters of mercury, used throughout. From this the number of nuclei per cubic centimeter becomes by equation (1)

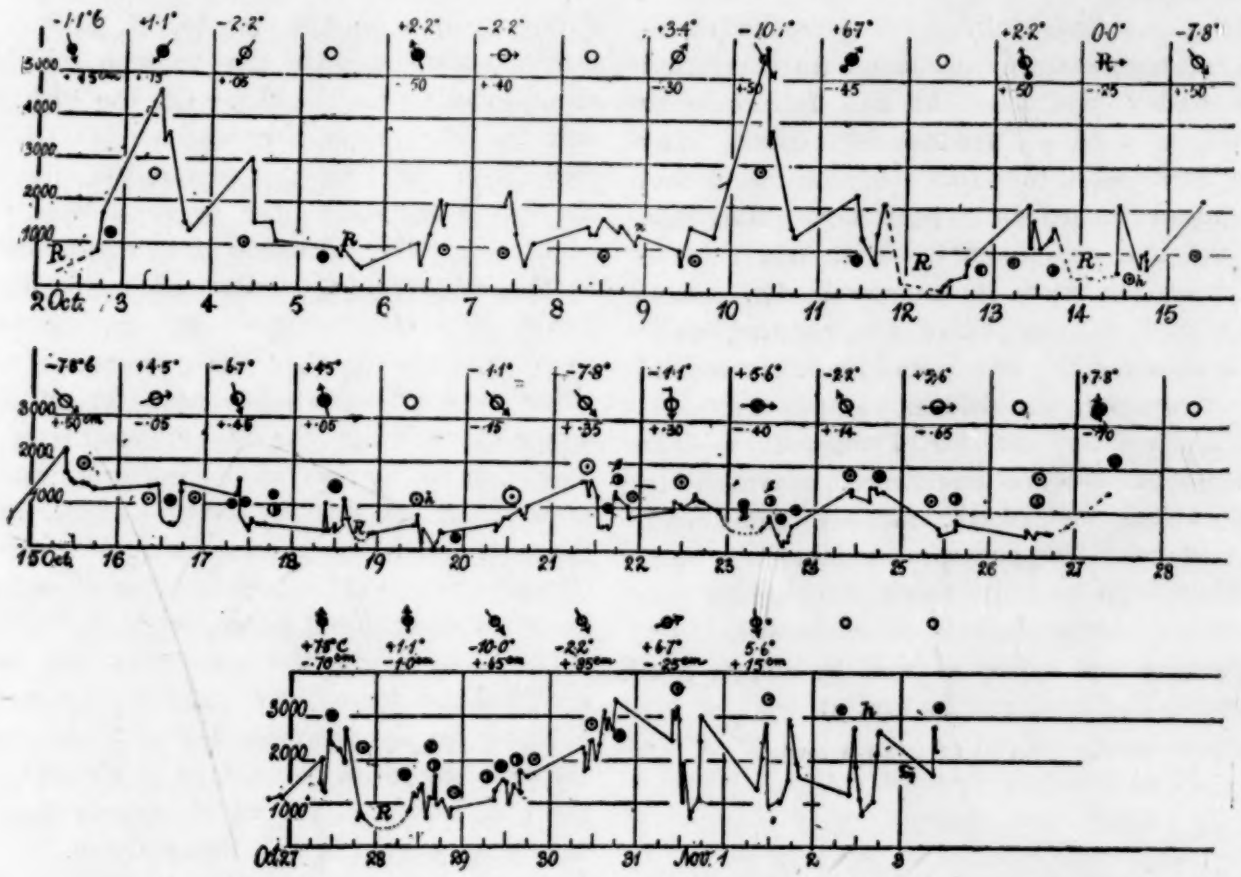
$$n = 189 \times s^3. \qquad (2)$$

4. *Errors.*—The occurrence of s^3 in (2) makes it unreasonable to expect very sharp data for n, since s is not obtainable from sharp lines. Differentiating equation (2)

* Read to the American Physical Society, October 18, 1902.

† The pioneering work of Aitken is well known. His apparatus, however, would be inconvenient for the purposes here in view.

logarithmically, an error of 1/20 in s (which need not be made) will be equivalent to an error of 34 per cent. in n. Hence the uncertainty is about 300 particles in 1,000. The variation of n is, however, somewhere between 0 and 5,000, and hence the large relative error is for the present at least without significance. The error of 300 particles is smaller, moreover, than the usual values of the minimum. Using the new long 'receiver,' s was measurable with an error less than 1/50, reducing the error of n to about 100 particles in 1,000. With properly constructed glass apparatus the conditions will be more favorable and thus fully adequate.



Finally, it should be noted for future consideration that for coronas of a high order (*i. e.*, with colored centers), the proportionality of n and s^3 is not at once assured.

5. *Preliminary Data.*—During the earlier observations made from October 2 to 14, the water-bath was not at hand. Though uncertain to this extent they are, nevertheless, very striking in their general bearing. I have, therefore, given them graphically in the chart (upper figure), where the number of nuclei is laid off vertically and the day of the month horizontally. The weather is specified as in the maps of the U. S. Weather Bureau, open circles denoting clear weather, usually with sun, black circles cloudy weather, and partially filled circles the intermediate case in which the heavens are not quite covered. *R* denotes rain. The change of temperature in degrees centigrade, during the last twelve hours, the change of the barometer in centimeters and the prevailing winds are given above the chart, for each day. Finally, *h* denotes hazy, *n* refers to observation much after sundown, etc. For convenience the observations are connected by straight lines, but where these supply the night hours they are naturally much in error.

The nucleation begins low on the second of October with the rain, but thereafter increases nearly fourfold with the bright weather of the succeeding days. Note the prevailing winds from the north. On the fifth and sixth, clouds and rain usher in a second minimum of nucleation. On the fair days

succeeding the nucleation is not as high as before until the tenth, when a sudden enormous increase occurs. The winds are here again from the north and there is marked fall of temperature. The high maximum is succeeded by an equally low minimum brought in by the rainy weather of the eleventh and twelfth. The nucleation then rises in the succeeding fair days, falls to a fourth minimum during the rain of the fourteenth, and then increases.

No doubt some fluctuation is due to variation of temperature for which no correction was made,* but the rain and fair weather effects, as a whole, are unmistakable. They here correspond to periods of minimum and maximum nucleation respectively. Moreover, the maxima are associated with winds blowing from the north in a general way, and at times with sudden fall of temperature, while the maxima of the fourth and tenth correspond to anticyclonal conditions.

6. *Data Corrected for Temperature.*—The subsequent observations were improved by aid of the water-bath, already mentioned, kept at room temperature, so that the temperature of the saturated air from which condensation takes place is fully known. The corrections are made as will be shown elsewhere. The final results are, at

10°C.	$m = 42 \times 10^{-8}$ gram.
20°	76
30°	128

From these a table may be interpolated showing the value of m for each degree of temperature between 10° and 30°, and, therefore, the number of nuclei per cubic centimeter is

$$n = 24 \times ms^3 \times 10^7$$

for the observed value of temperature and aperture, s.

In this way the following observations were corrected for temperature and the results are constructed in the graph (middle figure), beginning with October 14. Symbols referring to the weather and to other meteorological conditions are introduced as before above the graph.

7. *Remarks on the New Data.*—With the correction for temperature the curve has taken a smoother form, showing the method to be warranted; but the real cause of the differences of the two graphs is nevertheless due to actual differences of nucleation. What is particularly noteworthy is the occurrence of sharp minima on October 16, 17, 21 and 23, cotemporaneous with the passage of dense cloud masses over the sky. On the 16th, 21st and 23d the curve rises as soon as the sky clears; on the 17th this is not the case, but the curve runs into the overcast conditions of October 18. Another important feature is the remarkably pronounced minimum of nucleation on October 19, during clear weather, showing that the presence of sunshine cannot be the sole reason for an abundance of nuclei. The slight haze in the sky may not be ineffective. Similarly there is high nucleation on October 24 and 27, simultaneously with the overcast sky. A number of night observations made after October 18 show no exceptional behavior.

On October 27 the apparatus was again modified as stated, by substituting a long cylinder for the aspirator flask. Tests showed the new results to be uniformly higher* than the old, *cæt. par.*, for which reason they are separately given in the lower graph.

The data begin with high nucleation under an overcast sky and fall off to the rain storm of October 28. From this they rise again to values recalling the data of the early part of the month. The high nucleations are very fluctuating, conditions which would be even more apparent if night observations had been made. The cause is obviously convection and the diagram necessarily presents marked similarity to a wind curve.† The ascent on the 29th and the high values thereafter again

* As the air entered by a long pipe passing through the room, the temperature variations were probably within 5°C. The error so introduced is not a serious quantity, as was found by direct experiments subsequently made.

* This is due to the uneven thicknesses of the glass walls, a circumstance which need not here be considered.

† Cf. Langley, 'The Internal Work of the Wind,' 'Smithsonian Contrib.,' 1893.

correspond to winds coming in general from the north. The notched minima on the afternoons of October 31 and November 1 and 2 are curious novelties, but for them there is no other explanation than the possible haze effect as observed on the 2d.

INFERENCES.

8. *Variation.*—Mere inspection of the chart shows the extreme variability of atmospheric nucleation. Only a small part of this can be a local effect, since the changes correspond to the weather, though observation in cities where there is so much chance for pollution of the air is doubtless less satisfactory than work in the country would be. It is probable that even the small variations of the chart after October 15 are real. If the nuclei were colored the atmosphere would look like mottled soap, with the clear regions usually, but by no means always, accompanying rain or lying under clouds.

9. *Rain Effect.*—The observation next in importance is the occurrence of pronounced minima during rain, as for instance on October 2, 5, 12, 14, 19, 23, 28. There seems to be no exception to this rule. It implies a faster removal of nuclei by precipitation in a saturated atmosphere (the result of any fall of temperature) than the supply of nuclei to the same region, by either diffusion or subsidence or other more occult causes. But whether the deficiency is eventually made up from the lower air strata in contact with the lands and the seas, or from the higher air strata of the atmosphere where solar activity especially prevails, is left open.

Rain minima never fall quite down to the zero of nucleation, and are themselves quite variable in value.

One may note that the tendency of rain to change the normal air potential from positive to negative values is accompanied by a relative absence of nuclei. In other words minimum nucleation exists here cotemporaneously with maximum negative ionization.

10. *Cloud Effect.*—The third important feature, and one which became particularly evident after the temperature correction was applied (October 15), is the cloud minimum as seen on October 15, 17, 21, 23. Usually a higher nucleation is again established after the cloud train has passed over the sky, the phenomenon beginning and ending with periods of clear weather. At other times, however, the minimum remains, as on October 17.

The only explanation of this result, as will presently appear, is at hand; the air has moved bodily with the cloud, the whole constituting a region of deficient nucleation. The nuclei may have been precipitated by rain elsewhere, and the cloud may even have vanished from the region. To this extent, then, a region is identified by its nucleation.

11. *Solar Effect Absent.*—Since the nuclei cannot enter a region by diffusion as quickly as seen on October 21, for instance, one is tempted to believe that solar radiation is the cause by which the nucleation of a deficient region is reestablished. There is, however, no evidence for this in the observations, and much against it. Thus, on October 19, a remarkably low minimum is maintained almost all day in full sunlight; there were but few hazy clouds in the sky. This minimum was apparently only a part of the cloud region with which the day closed, but sunlight was powerless to replenish it. Similar reference may be made to the notched minima of November 1, 2 and 3. By contrast the high nucleation which occurs on October 25 and 27 in spite of an overcast sky may be cited. In the latter case, as on the 10th, the maximum is a precursor, as it were, of the storm which follows. Finally, though no observations were made after midnight, there are a number between sundown and ten o'clock. These show neither marked increments nor decrements, but have usually a normal character.

Hence there is no evidence, so far as these observations go, that ultra-violet light or other solar radiation has any potency in producing nucleation, and I have, therefore, explained the cloud effects, etc., as purely convective.

12. *Origin of Atmospheric Nuclei.*—Speculation as to the origin and character of these nuclei is premature. Conclusions must be

drawn with caution, since but few marked maxima have as yet been interpreted. True, the rain minima may in a general way be associated with atmospheric 'lows,' while the maxima on the 10th (and others in less marked degree) coincide with 'highs.' In so far as the cyclone and anticyclone may be regarded as upcast and downcast shafts, the supply of nuclei would seem to come from above. But as the rain minima admit of an independent explanation, and the remaining evidence is naturally vague, any such inference is precarious. Whether, therefore, the nucleation is the triturate of the land and the seas (particularly the latter), with contributions from bacteria, or whether the ultra-violet light or other radiation at the boundary of the atmosphere is the efficient source, must be left for future determination. The data already go far to show that from long series of observations of the above character much may be learned. Recalling that the coronas were obtained in ordinary glass bottles and are, therefore, distorted, the present project of studying nucleation seems secure, particularly as plate-glass apparatus will not be difficult to construct. It is, therefore, my purpose to install a small permanent plant at Brown University, and I shall take occasion to report progress if any novelty of sufficient interest makes its appearance.

Carl Barus.

THE LARAMIE CRETACEOUS OF WYOMING.

In the paper by Mr. Lambe and Professor Osborn on the mid-Cretaceous fauna of the Belly River deposits of Canada recently noticed in Science,* Professor Osborn has concluded, from the evidence presented by the vertebrate fossils, that a portion, at least, of those deposits in Montana which have previously been referred to the Laramie are really mid-Cretaceous in age, and perhaps contemporary with the Belly River series. Mr. Hatcher more recently † has called attention to the fact that a similar opinion had already been expressed by him concerning the Judith River deposits, and he is now inclined to locate them much earlier than the close of the Fox Hills time.

The Laramie deposits of Converse County, Wyoming, have usually been placed at the end of the Fox Hills, but I am somewhat skeptical of this. I believe that future research will show that, not only the Judith River beds, but also those of Wyoming will be found to be contemporary, in part at least, with the Fox Hills deposits, and that they are not separated by so great an interval from these other deposits which have hitherto been supposed to be contemporaneous.

This conclusion I base largely upon the fauna of the Wyoming beds, which present, in some respects at least, a startling resemblance to that of both the Judith River and the Belly River series.

Hitherto, almost our only published knowledge of the Wyoming Laramie fauna is that derived from Professor Marsh's writings. Aside from the Dinosaurs, he has described from these beds various lizard, snake and bird remains, but has said nothing of a number of other interesting forms of which he must have known. I can only attribute this neglect to a belief on his part that these other forms were identical with those described from the other deposits which he believed to be of equivalent age.

Among the collections made by the University of Kansas in Converse County in 1895, and those obtained by Professors Baur and Case in the same regions, there is not a little of interest in this connection. Not only a number of genera, but also a number of species previously described from Montana and now recognized by Lambe in the Belly River deposits, occur here in the supposed much later deposits of Wyoming. It would seem almost incredible that so many of these should have persisted unchanged through the long interval represented by so many thousand feet of Fox Hills deposits, to say nothing of those of the Fort Pierre. I doubt if a parallel can be found elsewhere in vertebrate paleontology. It is true that many of these forms from both the Judith River and the Laramie are known only from fragmentary remains, and that future researches may

* Science, October 24, 1902, p. 673.

† Science, November 21, 1902, p. 831.

show specific differences in some of them, but the resemblance in any event is marvelous.

The Converse County collections of which I have spoken include more or less numerous representatives of *Chamops, Iguanavus, Coniophis* and *Cimolopteryx,* originally described by Marsh from these regions, together with others that are yet new, and the following which have been recorded from other deposits only:

Myledaphus bipartitus Cope.—This species, originally described from the Montana beds, is common in the Wyoming deposits. The teeth are variable in size, and seem to agree well with that figured by Lambe from the Belly River deposits by Lambe. It is of interest to add that the genus is closely allied to, possibly identical with, *Rhombodus* Dames, from the uppermost Cretaceous of Europe. Jaekel shows clearly that *Rhombodus* belongs among the Trygonidæ.

Accipenser albertensis Lambe.—The keeled and ornamented shield figured by Lambe from the Belly River appears to be identical with others in the Baur collection from Wyoming. I suspect that they belong with a fish different from *Accipenser.*

Lepidosteus occidentalis Leidy.—Numerous scutes, associated with opisthocœlous vertebræ, from Converse County can not be distinguished from this species, originally described from the Judith River and recognized by Lambe from the Belly River.

Crocodilus humilis Leidy.—This species was described from the Judith River beds, and is identified by Lambe from the Belly River. Numerous teeth, scutes and vertebræ from the Converse County beds can not be distinguished.

Scapherpeton tectum Cope.—The four known species of this genus are typically from the Judith River beds. Lambe has identified the above species from the Belly River. Numerous vertebræ and fragments of the mandible are in the Wyoming collections, among which I recognize this species.

Champsosaurus.—This genus is well represented in the Laramie collections.

Aublysodon (*Deinodon,* preoc.).—Teeth of carnivorous dinosaurs are not at all rare in the Converse beds, some of which agree well with the figure of *A. explanatus* Cope given by Lambe.

Paleoscincus.—Teeth of three or four species from the Wyoming deposits are referred to this genus (evidently a composite one) among which there is one that seems identical with *P. asper,* described by Lambe from the Belly River.

Baëna is well represented in the collections, doubtless including *B. Hatcheri* among them, which is also known from the Belly River.

S. W. WILLISTON.

UNIVERSITY OF CHICAGO,
November 24, 1902.

BOTANICAL NOTES.

AIR HUMIDITY.

STUDIES made on the humidity of the air in an office in Lincoln, Nebr., by G. A. Loveland, and reported to the Nebraska Academy of Sciences, January, 1902, show that the air is much drier in the winter than is commonly supposed. Thus in an office in Nebraska Hall on the campus of the University of Nebraska the following results were obtained for the winter of 1899–1900.

	Mean Exterior Temperature.	Mean Relative Humidity.
December	22.6°	18.6 per cent.
January	26.8°	21.0 " "
February	19.2°	15.3 " "

The office in which these observations were made is on the main floor of a large brick building which is heated by steam, using ordinary pipe radiators. On the same floor a few feet away are the rooms of the Botanical Department, one of which is used for physiological experiments. It will be seen very readily that experiments upon ordinary plants must be made in such a dry air with considerable difficulty, and these results may help some students to understand why their work has been unsatisfactory. The air in such rooms is drier than in the driest climates in the world, and the effect on plants under observation can not be otherwise than most trying. Plants for study are taken from the

plant-houses, where the relative humidity is quite high, and are suddenly brought into an atmosphere as dry as that of the Sahara. What wonder that the plants do not behave properly!

POLYPORUS OFFICINALIS IN AMERICA.

Several years ago a correspondent in the Northwest sent me a fine specimen of a polypore which he found on the trunk of a tall tree in northern Idaho or western Montana. It was so inaccessible that he *shot* it from its resting place, bringing it down but little injured beyond the destruction of the attachment at the base of the fungus. As received it measured thirty centimeters in length and about thirteen centimeters in diameter, and was almost cylindrical in shape. This cylindrical mass evidently depended from a curved stipe at its upper end, but this had been destroyed as indicated above. The exterior was quite white, and was covered with a mealy coating derived apparently from the disintegration of the tissues of the fungus.

A year or two later another specimen was brought to me from the vicinity of the Yellowstone National Park (southward, I think), which agreed with the first one in all particulars excepting that it was much smaller, being not more than half the length and width of the first one. Both specimens are very certainly the *Polyporus officinalis* of the German Pharmacopœia, and like that species ours is very heavily loaded with a pungent resinous matter, to which doubtless its alleged medicinal properties are due. These specimens were reported as occurring on 'larch' trees, by which I suppose the correspondents meant some *Abies* or *Picea*. There can be no question as to the coniferous nature of the host trees, but I can not identify them further. As this species has not been reported as occurring in America, it is desirable that collectors should be on the lookout for it when botanizing in the Northwest.

BOTANY IN THE WASHINGTON MEETINGS.

Botanists should plan if possible to attend the meetings of the American Association for the Advancement of Science, and the affiliated societies in Washington during the holidays. This is the first time that these meetings are to be held in the winter, and no doubt the future policy of the association (and of the affiliated societies, also) will depend largely upon the success of the present meeting. According to the program as already announced, there will be meetings of interest to botanists as follows: The Section of Botany of the American Association for the Advancement of Science, American Microscopical Society, Botanical Society of America, Botanists of the Central and Western States, Society of American Bacteriologists, Society of Plant Morphologists, and Society for the Promotion of Agricultural Science. Doubtless, also, there will be meetings of the Botanical Club of the Association, as has been the practice for many years. When we add to all these the many botanical divisions and sections of the United States Department of Agriculture, with their laboratories, libraries, herbaria and plant-houses, and the great National Herbarium, the attraction should prove strong enough to bring out a large number of botanists.

TWO BOOKS ON FORESTRY.

Several months ago Professor Gifford brought out a book with the title 'Practical Forestry,' intended for beginning students of forestry in school and out, as well as for the general reader who wishes to get some knowledge of the subject. To this end the author has made his book as practical as possible, 'so that the owner of a large tract of woodland, and the farmer with his wood-lot, or the owner of a country place, or those interested in the various industries connected with forests and forest products, may glean hints of value.' A pretty careful examination of the book shows that Professor Gifford has succeeded in making such a book as he describes, and without question it will do much good in the country at large. It consists of four parts, as follows: Part I., which is introductory, dealing with the generalities of the subject; Part II., 'The Formation and Tending of Forests'; Part III., 'The Industrial Importance of Forests'; Part IV., 'Sup-

plementary,' including a description of the principal federal and state reservations, and a descriptive list of fifty of the principal forest trees of North America. The text is clearly written, and the publishers (Appletons) have done their duty in the way of type, paper and illustrations.

The second book, by Professor Roth, is entitled 'First Book of Forestry.' In it the author has attempted 'to present in simple, non-technical language some of the general principles underlying the science, and to state the methods whch are employed and the objects to be attained in the practice of forestry.' As indicated, the treatment is very simple, and a perusal of its pages shows that the book might easily be used in the public schools. The present writer would suggest this book as one to be used for supplementary reading in connection with work in reading and nature study. A citation of a few of the topics will show the simple style of the book, as follows: 'What Light and Shade do for the Woods'; 'What Different Soils do for the Woods'; 'What Moisture does for the Woods'; 'Care and Protection of the Forest'; 'Use of the Forest'; 'Forest Plantations on the Prairies.' The publishers (Ginn) have made a pretty book of the text and illustrations so well supplied by the author.

THREE FORESTRY JOURNALS.

WITH the increased interest in forestry in this country have come several journals devoted to this subject. The oldest of these is *Forestry and Irrigation* (published in Washington, D. C.), which began in 1895 under the name of *The Forester,* and after seven years enlarged its scope and changed its name. In addition to forestry it now devotes a good deal of attention to irrigation, which in many portions of the country is so intimately associated with the growth of trees. This journal is the official organ of the American Forestry Association, and because of the support given it by the staff of the United States Bureau of Forestry it is, to a certain extent, the organ of this government bureau. Beginning in a modest way, it has improved year by year until it has become a journal which is of interest to scientific botanists, as well as the practical men to whom it is supposed to particularly appeal. This journal illustrates very well the fact that science and its practical applications are coming to be more and more closely associated. The botanist can no longer overlook many of the papers which are published in a journal of this kind. Among recent papers may be mentioned the following: 'The Mesquite, a Desert Study'; 'The Beetle Pest in the Black Hills Forest Reserve'; 'Recent Progress in Dendro-chemistry'; 'The Jack Pine Plains of Michigan'; 'The Climate of the White Pine Belt'; 'Notes on a Northwestern Fir'; 'The Red Cedar in Nebraska'; '*Pinus attenuata* as a Water Conserver'; 'Forestry and Plant Ecology'; etc.

In September of the present year a second journal of forestry appeared in Chicago, under the name of *Arboriculture.* It is quite distinctly a popular journal, and, since it is illustrated with good 'half-tones,' it is likely to appeal to a large constituency and do much toward creating and stimulating an interest in forestry.

A third journal devoted to forestry has come to us from Cornell University within the last few weeks, under the name of the *Forestry Quarterly.* It is published under the direction of the faculty of the College of Forestry, and is considerably more technical in nature than either of the preceding. In addition to a number of valuable general papers there is one feature which will commend itself to most botanical readers, viz: the full account of the current forestry literature, much of which is of immediate interest. This journal must find a place in every botanical library.

CHARLES E. BESSEY.

THE VIRCHOW MEMORIAL.

A MEETING was held in London on November 21 to forward the movement to take part in the erection of a statue to Rudolf Virchow in Berlin. Lord Lister presided and addresses were made by a number of leading men of science. An influential committee was formed with Lord Lister as chairman, Lord Avebury as treasurer and Sir Felix Semon as secretary.

This committee has issued the following appeal:

A movement has been inaugurated in Germany to erect a statue at Berlin to the late Professor Rudolf Virchow.

Representatives of science and art, irrespective of political parties, have joined the committee constituted for this purpose, and it is hoped that the appeal recently issued by the committee will meet with a very general response.

At the same time it is felt that this movement ought to be more than an exclusively German one. Professor Virchow's labors in medicine, public health, anthropology, ethnology, and archeology have benefited the world at large, and amongst his pupils have been men of every nationality. It is believed that in this country in particular, of which he was ever a staunch friend, and amongst the men of science of which he numbered many devoted admirers, a general desire will be felt to participate in the movement intended to do homage to him at the seat of his labors.

With this object a British committee has been formed, the chairmanship of which has been undertaken by Lord Lister, with Lord Avebury as hon. treasurer, and Sir Felix Semons as hon. secretary.

The committee now invite subscriptions from all those who wish to pay a last tribute to the memory of one of the greatest men of our time. Whilst it has been decided not to limit the *maximum* amount of contributions, in order not to check the generosity of those who may desire to show in a substantial form their appreciation of Professor Virchow's services to humanity, the committee are particularly anxious that it should be understood that even the smallest contributions will be cordially welcomed, as the main object of the British collection is to testify to the widespread amount of esteem and veneration which the deceased scientist enjoyed in this country.

Cheques and postal orders made payable to 'Virchow Memorial,' and crossed 'Messrs. Robarts, Lubbock and Co.,' may be sent to 'the Hon. Treasurer of the Virchow Memorial, care of Messrs. Robarts, Lubbock and Co., 15, Lombard street, London, E. C.,' who will send an acknowledgment to the individual contributors.

When the list has been closed, the hon. treasurer will forward the amount to the treasurer of the Berlin committee, together with a list of the contributors, but the amount of the individual contributions will not be stated.

We enclose a list of the committee, and have the honor to remain, Sir,

Yours faithfully,

LISTER,
AVEBURY,
FELIX SEMON.

London, November 21.

LECTURE COURSES OF THE NATIONAL GEOGRAPHIC SOCIETY.

DURING the season of 1902–1903 the National Geographic Society presents in Washington, D. C., three courses of meetings—popular lectures, technical meetings and lenten lectures. These courses have been planned with great care to include those problems of a geographic character which are of special interest to the general public at the present time. Arrangements have been made for addresses in the popular course on the geographic distribution and mining of hard and soft coal, Mr. Peary's work in the Arctics during the last four years, the tragedy of Saint Pierre, Colombia and the Isthmian Canal, the commercial expansion of Argentina and the Macedonian question. The arrangements for the later part of the season are so far provisional as to permit the introduction of specially timely topics.

The interest shown last year in the technical meetings, which were planned for scientific men actively engaged in geographic work and for persons specially interested in such work, has led the board to continue such meetings.

The subject of the afternoon, or lenten, course will be announced in a later program.

The popular course will be delivered in the National Rifles Armory, G street between Ninth and Tenth streets northwest, on Friday evenings, at 8 o'clock, commencing November 14 and alternating with the technical meetings, which will be held in the Assembly Hall of Cosmos Club until the new home of the Society on Sixteenth and M streets is completed. The following dates have been definitely assigned:

November 14—'The Coal Resources of the United States' (illustrated), Dr. David T. Day, Chief Division of Mineral Resources, U. S. Geolog-

ical Survey. Dr. Day will discuss the geographical distribution of soft and hard coal in the United States, the methods of mining, and the manner in which the output is distributed throughout the country.

November 29—'Explorations in the Arctics, 1898–1902' (illustrated), Commander Robert E. Peary, U.S.N. Mr. Peary will describe his Arctic work of the last four years, during which he gained the most northerly known land and the highest point yet reached on the western hemisphere.

December 12—'Argentina, Present and Future' (illustrated), E. L. Corthell, C.E. Mr. Corthell for the past two years has been consulting engineer of the Ministry of Public Works in Argentina, and has thus had an exceptional opportunity to study the recent remarkable development and the tremendous possibilities of this vast South American republic.

January 9—'The Turk and His Rebellious Subjects' (illustrated), Mr. William E. Curtis. The restless and heterogeneous people of Macedonia and of the Sultan's European provinces will be the subject of an interesting address by Mr. Curtis.

January 23—'The Tragedy of Saint Pierre' (illustrated), Mr. George Kennan.

Provisional arrangements have also been made for lectures on Colombia and the Isthmian Canal; 'America before the Advent of Man'; 'The Geographic Distribution of Insanity in the United States'; 'Russia of To-day' (by Paul du Chaillu), and a lecture by Mr. John Muir.

Regular meetings of the society for the presentation of technical papers and discussion will be held on Friday evenings, at 8 o'clock, commencing November 7, and alternating with the popular lectures. As the new home of the society will not be completed before January 15, 1903, these meetings will be held for the present in the Assembly Hall of the Cosmos Club. The course has been planned to form a series on the geographic work of the great scientific bureaus of the government. Mr. Richard U. Goode, chairman of the committee on technical meetings, announces the following program:

November 7—'Some of the Administrative and Industrial Problems of Porto Rico,' Hon. Wm. F. Willoughby, Treasurer of Porto Rico.

November 21—'The Work of the U. S. Coast and Geodetic Survey,' Hon. O. H. Tittmann, Superintendent U. S. Coast and Geodetic Survey.

December 5—'The Work of the U. S. Weather Bureau,' Dr. Willis L. Moore, Chief U. S. Weather Bureau.

December 19—'The U. S. Signal Corps,' Gen. A. W. Greely, Chief Signal Officer, U.S.A.

At later meetings the geographic work of the Hydrographic Office of the Navy Department, of the Experiment Stations of the Agricultural Department, of the Census Office, of the Naval Observatory, of the Geological Survey and of the Library of Congress will be discussed.

The lenten course of five lectures will be delivered in Columbia Theater, F street, near Twelfth, at 4:20 o'clock, on Wednesday afternoons of February 11, 18, 25 and March 4, 11. The subject of this course and the speakers assigned for the special topics will be announced in a later program.

The headquarters of the society will continue to be Rooms 107–108 Corcoran Building, Washington, D. C., until the new home of the society, on the southwest corner of Sixteenth and M streets, is completed.

A GENERAL MEETING OF THE AMERICAN PHILOSOPHICAL SOCIETY.

A COMMITTEE of this society, with Professor George F. Barker as chairman and Dr. I. Minnis Hays as secretary, has sent out the following letter:

The very gratifying success of the general meeting of The American Philosophical Society, held last April, has established most satisfactorily the claim that the interests of useful knowledge in the United States may be greatly promoted by holding an annual general meeting of the society. Such a meeting, not only from the information derived from the papers presented, but also from their discussion, has proved attractive to its members from all parts of the country and has markedly broadened the field of usefulness of this, the oldest scientific society in America.

At the concluding session of the general meeting held last April it was unanimously resolved that a second general meeting be held in April, 1903. In accordance with this resolution the said general meeting of the society will take place

on Thursday and Friday, April 2 and 3, 1903, and the undersigned have been appointed a committee to make the necessary arrangements.

Members desiring to present papers, either for themselves or others, are requested to send to the secretaries at as early a date as practicable and not later than March 1, 1903, the titles of these papers, accompanied by a brief abstract, so that they may be duly announced on the program which will be issued immediately thereafter, and which will give in detail the arrangements for the meeting.

Papers in any department of science come within the scope of the society which, as its name indicates, embraces the whole field of useful knowledge.

The publication committee, under the rules of the society, will arrange for the immediate publication of the papers presented.

The society by means of its publications, which present a series covering 140 years and include *Transactions* in quarto and *Proceedings* in octavo, with its large exchange list embracing, practically, the scientific societies of the world, and with its exceptional facilities for immediate issue, offers unexceled avenues for prompt publication and wide circulation of the papers read before it.

SCIENTIFIC NOTES AND NEWS.

It is reported that the Nobel prizes for this year will be awarded as follows: In chemistry, to Professor Emil Fischer, of Berlin; in physics, to Professor S. A. Arrhenius, of Stockholm; in medicine, to Professor Niels E. Finsen, of Copenhagen, and to Major Ronald Ross, of Liverpool. The value of these prizes, it will be remembered, is about $40,000 each.

Professor H. V. Hilprecht has been awarded the Lucy Wharton Drexel medal of the University of Pennsylvania for his archeological researches.

We learn from *Nature* that Dr. P. L. Sclater, F.R.S., has resigned the secretaryship of the Zoological Society of London, and only holds office until his successor is appointed. The council has passed the following resolution on this subject and ordered it to be entered on their minutes:

The president, vice-presidents and council of the Zoological Society of London desire to record their sincere regret at the retirement of their secretary, Dr. Philip Lutley Sclater, after a service of nearly forty-three years. They wish to tender him their hearty thanks for his most valuable services to the Society during this long period, not only in the management of the Zoological Gardens, but also in the conduct of the publications of the Society and the general direction of its affairs. These affairs have prospered to a remarkable degree during his long term of office. The income of the Society has doubled, the Society's library has been entirely created, the membership has increased from 1500 to 3200. Dr. Sclater's own work as a zoologist is held in universal repute, and it is no exaggeration to say that the very high position occupied at the present day by the Zoological Society in the world of science is largely due to the exertions and the personal character of its retiring secretary.

Dr. Gary N. Calkins, of the department of zoology of Columbia University, has been appointed consulting biologist to the New York State Pathological Hospital.

Dr. G. T. W. Patrick, professor of philosophy and psychology, in the University of Iowa, is spending the year in Germany.

Dr. Sven Hedin, the Swedish explorer, is expected to lecture in the United States early next year.

Dr. Robert Koch has presented to the Mount Vernon Hospital for Consumption, London, a portrait of himself.

The French International Geodetic Assotion has elected General Bassot as vice-president in succession to General Ferrero.

The ashes of Christopher Columbus, removed from the cathedral of Havana, were placed in a mausoleum in Saville cathedral on November 17.

We regret to record the death of Professor Henry Mitchell, the eminent engineer. He was born in Nantucket in 1830, being the son of William Mitchell, the astronomer. His sister, Maria Mitchell, was also well known as an astronomer. Mr. Mitchell was at one time professor in the Massachusetts Institute of Technology and took part in important engineering works in the harbors of Boston, Philadelphia and other cities. He took part in the surveys of the Mississippi river and of

the Panama canal route. His publications were chiefly connected with tides, river currents and other hydrological subjects. He was a member of the National Academy of Sciences and fellow of the American Association for the Advancement of Science.

MR. C. E. HOUGHTON has been appointed associate professor of mechanical engineering in New York University.

SIR JOHN STOKES, an eminent British engineer, died on November 17 at the age of seventy-seven years. He carried out important engineering works in connection with the Suez Canal, the opening of the mouth of the Danube and in other directions.

MR. H. C. HILL, inspector-general of forests to the government of India, died on November 7 at the age of fifty years.

THE death is also announced of Dr. T. R. Segelcke, professor of dairy farming in the Agricultural College at Copenhagen.

THE Harvard Corporation has voted to extend its Christmas holidays to January 5, thus leaving the week free for the convocation of scientific societies. Harvard University is, we believe, the only important institution that had not taken action favorable to Convocation Week.

M. GIACOBINI discovered a faint comet at Nice on December 2, and the comet was observed at the Naval Observatory on December 3.

THE Civil Service Commission announces an examination on January 3 for the position of assistant-chief, Dairy Division, Department of Agriculture, at a salary of $1,800. It announces on January 6 examinations for the positions of scientific assistant in the Fish Commission and custodian in the Marine Biological Station at Beaufort, at salaries of $720, and for the position of assistant chemist in the supervising architect's office, Treasury Department, at a salary of $1,200.

THE Section of Geology and Geography of the American Association has arranged to devote a session of the meeting to the discussion of the recent eruptions of Mont Pelée and La Soufrière by the geologists, Messrs. Russell, Hill, Heilprin, Jaggar, Curtis and Hovey, who visited the islands of Martinique and St. Vincent last summer, but the details of the session have not been elaborated in time for the preliminary program. The following papers, however, can be announced:

R. T. HILL: 'The geologic and physiographic history of the Lesser Antilles.' With illustrations.

E. O. HOVEY: 'The ejecta of the 1902 eruptions of La Soufrière, St. Vincent'; 'Some erosion phenomena on Mt. Pelée and La Soufrière,' with illustrations; 'The inner cone of the Mt. Pelée crater and its relation to the destruction of Morne Rouge.'

T. A. JAGGAR, JR.: 'The geological and recent history of the Caribbean volcanoes'; 'The protection of human life from volcanoes.'

ISRAEL C. RUSSELL: 'Martinique and St. Vincent.' (An illustrated lecture before the National Geographic Society, in connection with the meeting of the American Association for the Advancement of Science.)

J. W. SPENCER: 'The geological history of the Caribbean Islands.' With charts and illustrations.

THE ninth annual meeting of the American Mathematical Society will be held at Columbia University on Monday and Tuesday, December 29 and 30. The council will meet on Monday morning, and the annual election of officers and other members of the council will close on Tuesday morning. At the opening of the afternoon session on Monday the retiring President, Professor Eliakim Hastings Moore, will deliver his presidential address, the subject of which will be: 'The Foundations of Mathematics.'

THE Lowell Institute lectures for the current year include the following:

Professor N. S. Shaler, ten lectures on the general topic, 'Dynamical Geology.'

Professor H. P. Bowditch, eight lectures on 'Some Problems of Modern Physiology.'

Dr. T. A. Jaggar, six lectures on 'The Caribbean Volcanic Eruptions and their Bearing on Vulcanology.'

THE city of Ann Arbor has offered to the University of Michigan the perpetual lease of a piece of land of seven acres within one square of the present campus on condition that the

University improve the same, converting it into a botanical garden to parts of which the public shall have admission. The regents have signified their willingness to accept the offer, and will doubtless begin work on the land next spring. The ground is well adapted to garden purposes, three acres being high and level, and this area then running down a steep hillside some fifty feet to low land containing a natural pool.

At the invitation of Columbia University, the fourth annual conference of the Association of American Universities is to be held in New York on December 29, 30 and 31.

The first sanitary conference of the American republics convened at Washington last week. The Governments of Mexico, Cuba, Chili, Costa Rica, Salvador, Honduras and the United States were represented. Dr. Walter Wyman, surgeon general of the marine hospital service, presided at the opening session and addresses of welcome were made by Secretary of the Treasury Shaw and Assistant Secretary of State Hill.

The Ludwick Institute Courses of free lectures on the natural sciences and their applications, given under the auspices of the Academy of Natural Sciences of Philadelphia, on Mondays and Thursdays are for the present year as follows: Hygiene and physiology, by Seneca Egbert, A.M., M.D., beginning on November 13; Entomology, by Henry Skinner, M.D., beginning on November 17; Some phases of bird life, by Witmer Stone, M.A., beginning on January 5; The faunas of the new American dependencies, Porto Rico and Cuba, Hawaii and the Philippines, by Henry A. Pilsbry, Sc.D., beginning on February 5; Animals of the deep sea: a historical sketch of their discovery, by Philip P. Calvert, Ph.D., beginning on February 9; Geological history; descriptions of some critical epochs in the history of the earth, by Amos P. Brown, Ph.D., beginning on February 12; Vertebrate paleontology: types of extinct fishes and batrachians and their living kin, by J. Percy Moore, beginning on March 16; Characteristic features of the chief plant groups, by Stewardson Brown, beginning March 19.

UNIVERSITY AND EDUCATIONAL NEWS.

George Foster Peabody has offered to the University of Georgia a $50,000 building, provided the Legislature will appropriate to the University for maintenance the sum of $10,000 a year for two years and make improvements costing $1,200.

The University of California is about to erect a physiological laboratory at a cost of $25,000. It will be under the charge of Dr. Jacques Loeb, recently called to the University from Chicago.

The Yale Club of Chicago has voted to establish in the academic and scientific departments of the university four annual scholarships of $600 each, to be given to students who are residents of Illinois. Beneficiaries will give notes for the amounts of the scholarships to be repaid at intervals after graduation.

The education bill has been passed by the British House of Commons. Less attention has been paid to this bill in the United States than it deserves. It to a certain extent nationalizes the church and other religious schools, supporting them from a government grant and from local rates, but leaving them in part under ecclesiastical authority and permitting them to continue their religious teaching.

The regents of the University of the State of New York have elected the Rev. William Croswell Doane chancellor in the room of the late Anson J. Upson. Mr. Whitelaw Reed was elected vice-chancellor.

Dr. A. S. Chittenden has been appointed assistant in pathology in the College of Physicians and Surgeons, Columbia University.

Major Ronald Ross has been elected to the newly established chair of tropical medicine at University College, London.

M. Marey has succeeded the late M. Lacaze-Duthiers as president of the section of natural sciences of the Ecole pratique des hautes etudes, Paris.

Dr. O. Juel has been appointed professor of botany in the University of Upsala.